Electrical network protection

# Sepam series 40

## User's manual
03/2011

Schneider Electric

# Safety instructions

## Safety symbols and messages

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

*ANSI symbol.*

*IEC symbol.*

### Risk of electric shock

The addition of either symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

### Safety alert

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### Safety messages

| ⚠ DANGER |
| --- |
| **DANGER** indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury. |

| ⚠ WARNING |
| --- |
| **WARNING** indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury. |

| ⚠ CAUTION |
| --- |
| **CAUTION** indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury. |

| CAUTION |
| --- |
| **CAUTION**, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damages. |

## Important notes

### Restricted liability

Electrical equipment should be serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this manual. This document is not intended as an instruction manual for untrained persons.

### Device operation

The user is responsible for checking that the rated characteristics of the device are suitable for its application. The user is responsible for reading and following the device's operating and installation instructions before attempting to commission or maintain it. Failure to follow these instructions can affect device operation and constitute a hazard for people and property.

### Protective grounding

The user is responsible for compliance with all the existing international and national electrical codes concerning protective grounding of any device.

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**Protection functions**

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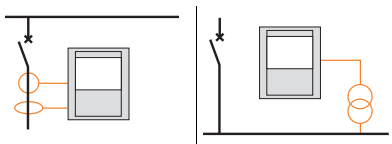
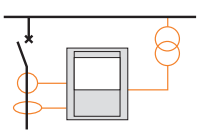
# Selection guide by application



The selection guide by application suggests Sepam type(s) suitable for your protection requirements, based on your application characteristics. The most typical applications are presented along with the associated Sepam type.
Each application example is described:

- ■ By a single-line diagram specifying
  - □ the device to be protected
  - □ the network configuration
  - □ the position of the metering sensors
- ■ By the standard and specific Sepam functions to be implemented to protect the application concerned.





| | | Series 20 | | | | Series 40 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Protections** | | | | | | | | | | |
| | Current | ■ | ■ | | | ■ | ■ | ■ | ■ | ■ |
| | Voltage | | | ■ | ■ | ■ | ■ | ■ | | ■ |
| | Frequency | | | ■ | ■ | ■ | ■ | ■ | | ■ |
| | Specific | | Breaker failure | | Disconnection (ROCOF) | | Directional earth fault | Directional earth fault and phase | Directional earth fault | |
| **Applications** | | | | | | | | | | |
| Substation | | S20 | S24 | | | S40<br>S50 (4) | S41<br>S51 (4) | S42<br>S52 (4) | S43<br>S53 (4) | S44<br>S54 |
| Busbar | | | | B21 | B22 | | | | | |
| Transformer | | T20 | T24 | | | T40<br>T50 (5) | | T42<br>T52 (5) | | |
| Motor | | M20 | | | | M40 | M41 | | | |
| Generator | | | | | | G40 | | | | |
| Capacitor | | | | | | | | | | |
| **Characteristics** | | | | | | | | | | |
| Logic inputs/ outputs | Inputs | 0 to 10 | | 0 to 10 | | 0 to 10 | | | | |
| | Outputs | 4 to 8 | | 4 to 8 | | 4 to 8 | | | | |
| Temperature sensors | | 0 to 8 | | 0 to 8 | | 0 to 16 | | | | |
| Channel | Current | 3I + I0 | | – | | 3I + I0 | | | | |
| | Voltage | – | | 3V + V0 | | 3V | | | | |
| | LPCT (1) | Yes | | – | | Yes | | | | |
| Communication ports | | 1 to 2 | | 1 to 2 | | 1 to 2 | | | | |
| Control | Matrix (2) | Yes | | Yes | | Yes | | | | |
| | Logic equation editor | – | | – | | Yes | | | | |
| | Logipam (3) | – | | – | | – | | | | |
| Other | Memory cartridge with settings | – | | – | | – | | | | |
| | Backup battery | – | | – | | – | | | | |

*(1) LPCT: Low-Power Current Transducer conforming to standard IEC 60044-8.*
*(2) Control matrix used for simple assignment of data from the protection, control and monitoring functions.*
*(3) Logipam: Ladder language PC programming environment for extended use of Sepam series 80 functions.*
*(4) S5X applications are identical to S4X applications with the following additional functions:*
- *■ earth fault and phase overcurrent cold load pick-up*
- *■ broken conductor detection*
- *■ fault locator*

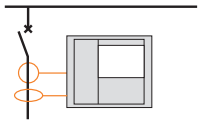
*(5) T5X applications are identical to T4X applications with the following additional functions:*
- *■ earth fault and phase overcurrent cold load pick-up*
- *■ broken conductor detection*

# Selection guide by application



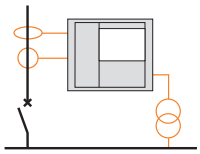
The list of protection functions is given for information only.
Direct earthing or impedance earthing have been represented by the same pictogram, i.e. by a direct earthing system.

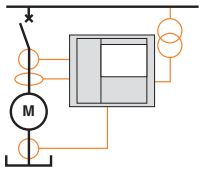
## Series 60

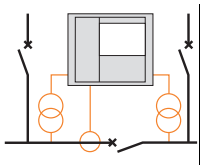


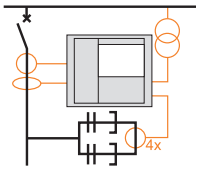
| | | |
|---|---|---|
| ■ | ■ | ■ |
| ■ | ■ | ■ |
| ■ | ■ | ■ |
| | Directional earth fault | Directional earth fault and phase |
| | | |
| B80 | | B22 |
| | | |
| T60 | | T62 |
| | M61 | |
| G60 | | G62 |
| C60 | | |
| | | |
| 0 to 28 | | |
| 4 to 16 | | |
| 0 to 16 | | |
| 3I + I0 | | |
| 3V, 2U + V0 or Vnt | | |
| Yes | | |
| 1 to 2 | | |
| Yes | | |
| Yes | | |
| – | | |
| Yes | | |
| Yes | | |

## Series 80









| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Directional earth fault | Directional earth fault and phase | Disconnection (ROCOF) | Transformer or machine-transformer unit differential | Machine differential | Busbar voltage and frequency protection | Capacitor bank unbalance |
| | | | | | | | |
| S80 | S81 | S82 | S84 | | | | |
| B80 | | | | | | B83 | |
| | T81 | T82 | | T87 | | | |
| | M81 | | | M88 | M87 | | |
| | | G82 | | G88 | G87 | | |
| | | | | | | | C86 |
| | | | | | | | |
| 0 to 42 | | | | 0 to 42 | | 0 to 42 | 0 to 42 |
| 5 to 23 | | | | 5 to 23 | | 5 to 23 | 5 to 23 |
| 0 to 16 | | | | 0 to 16 | | 0 to 16 | 0 to 16 |
| 3I + 2 x I0 | | | | 2 x 3I + 2 x I0 | | 3I + I0 | 2 x 3I + 2 x I0 |
| 3V + V0 | | | | 3V + V0 | | 2 x 3V + 2 x V0 | 3V + V0 |
| Yes | | | | Yes | | Yes | Yes |
| 2 to 4 | | | | 2 to 4 | | 2 to 4 | 2 to 4 |
| Yes | | | | Yes | | Yes | Yes |
| Yes | | | | Yes | | Yes | Yes |
| Yes | | | | Yes | | Yes | Yes |
| Yes | | | | Yes | | Yes | Yes |
| Yes | | | | Yes | | Yes | Yes |

*All the information relating to the Sepam range can be found in the following documents:*

- *Sepam catalog, reference SEPED303005EN*
- *Sepam series 20 user's manual, reference PCRED301005EN*
- *Sepam series 40 user's manual, reference PCRED301006EN*
- *Sepam series 60 user's manual, reference SEPED310017EN*
- *Sepam series 80 functions user's manual, reference SEPED303001EN*
- *Sepam series 80 Modbus communication user's manual, reference SEPED303002EN*
- *Sepam series 80 operation manual, reference SEPED303003EN*
- *Sepam DNP3 communication user's manual, reference SEPED305001EN*
- *Sepam IEC 60870-5-103 communication user's manual, reference SEPED305002EN*
- *Sepam IEC 61850 communication user's manual, reference SEPED306024EN*

# Protection functions suitable for low voltage



## Low voltage earthing systems

There are 4 low voltage (LV) earthing systems designated by a 2 or 3-letter acronym:

- TN-S
- TN-C
- TT
- IT

The letters making up the acronym have the following meanings:

| Letter | | Meaning |
|---|---|---|
| **First letter** | | **Transformer neutral point** |
| | I | Earthed with an impedance |
| | T | Directly earthed |
| **Second letter** | | **Electrical exposed conductive parts of the consumer** |
| | T | Earthed |
| | N | Connected to the neutral conductor |
| **Third letter (optional)** | | **Protective Earth conductor** |
| | S | Separate N neutral conductor and PE Protective Earth conductor |
| | C | Combined N neutral conductor and PE Protective Earth conductor (PEN) |

# Protection functions suitable for low voltage



## Compatibility of Sepam low voltage protection functions

Sepam protection functions can be used with low voltage (LV) as long as the conditions below are met:

- The distribution circuit must be rated higher than 32 A.
- The installation must comply with standard IEC 60364.

For additional information about the compatibility of Sepam protection functions with low voltage, please contact Schneider Electric technical support.

The table below lists the Sepam protection functions suitable for low voltage according to the earthing system used. Sepam protection functions not listed in this table are not suitable for low voltage. The protection functions listed in this table are available according to the Sepam type.

| Protection | ANSI code | Earthing system | | | | Comments |
|---|---|---|---|---|---|---|
| | | TN-S | TN-C | TT | IT | |
| Phase overcurrent | 50/51 | ■ | ■ | ■ | ■ | Neutral conductor not protected |
| Earth fault/Sensitive earth fault | 50N/51N | ■ | ■ | ■ | (1) | |
| Earth fault/Sensitive earth fault | 50G/51G | ■ | ■ | ■ | (3) | |
| Negative sequence/unbalance | 46 | ■ | ■ | ■ | ■ | Threshold to be adapted to the phase unbalance |
| Thermal overload for cables/machine/capacitor | 49RMS | ■ | ■ | ■ | ■ | Neutral conductor not protected |
| Restricted earth fault | 64REF | ■ | ■ | ■ | (3) | |
| Two-winding transformer differential | 87T | ■ | ■ | ■ | ■ | |
| Directional phase overcurrent | 67 | ■ | ■ | ■ (4) | ■ (4) | |
| Directional earth fault | 67N/67NC | | | | | Incompatible with LV diagrams (4-wire) |
| Directional active overpower | 32P | ■ | ■ | (2) | (2) | |
| Directional reactive overpower | 32Q | ■ | ■ | (2) | (2) | |
| Undervoltage (L-L or L-N) | 27 | ■ | ■ | ■ | ■ | |
| Remanent undervoltage | 27R | ■ | ■ | ■ | ■ | |
| Overvoltage (L-L or L-N) | 59 | ■ | ■ | ■ | ■ | |
| Neutral voltage displacement | 59N | ■ | ■ | (4) | (4) | Residual voltage not available with 2 VTs |
| Negative sequence overvoltage | 47 | ■ | ■ | ■ | ■ | |
| Overfrequency | 81H | ■ | ■ | ■ | ■ | |
| Underfrequency | 81L | ■ | ■ | ■ | ■ | |
| Rate of change of frequency | 81R | ■ | ■ | ■ | ■ | |
| Synchro-check | 25 | ■ | ■ | ■ | ■ | |

■ *: Protection function suitable for low voltage (according to Sepam)*

***(1)*** *Not recommended even on the second fault.*

***(2)*** *2-wattmeter method not suitable for unbalanced loads.*

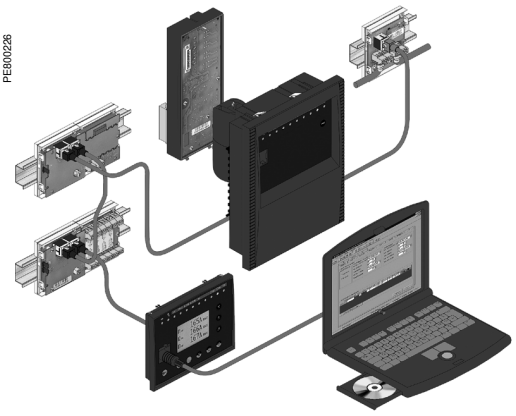
***(3)*** *Residual current too low in IT.*

***(4)*** *2 phase-to-phase VTs.*

# Presentation



PE800226



*Sepam series 40, a modular solution.*

The Sepam series 40 family of protection and metering units is designed for the operation of machines and utility substations and electrical distribution networks in industrial installations for all voltage levels.
It consists of simple, high-performance solutions, suited to demanding applications that call for current and voltage metering.

**Sepam series 40 selection guide by application**

| **Selection criteria** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Basic protection functions | I | | I, U and f | | I, U and f | | I, U and f | |
| Specific protection functions | Directional earth fault | | | | Directional earth fault | | Directional earth fault and phase overcurrent | |
| **Applications** | | | | | | | | |
| Substation | S43 | S53 (1) | S40 | S50 (1) | S41 | S51 (1) | S42 | S52 (1) |
| | | | S44 | S54 | | | | |
| Transformer | | | T40 | T50 (2) | | | T42 | T52 (2) |
| Motor | | | M40 | | M41 | | | |
| Generator | | | G40 | | | | | |

***(1)** S5X applications are identical to S4X applications with the following additional functions:*
- *earth fault and phase overcurrent cold load pick-up*
- *broken conductor detection*
- *fault locator*

***(2)** T5X applications are identical to T4X applications with the following additional functions:*
- *earth fault and phase overcurrent cold load pick-up*
- *broken conductor detection*

PE80315

*Sepam series 40 with basic UMI and with fixed advanced UMI.*

## Main functions

### Protection

- phase protection and earth fault protection with adjustable reset time, with switching of the active group of settings and logic discrimination
- earth fault protection insensitive to transformer switching
- RMS thermal overload protection that takes into account external operating temperature and ventilation operating rates
- directional earth fault protection suitable for all isolated, compensated or impedant neutral systems
- directional phase overcurrent protection with voltage memory
- voltage and frequency protection functions (under/over, etc.).

### Communication

Sepam can be connected to a supervision communication network (S-LAN) based on the following communication protocols: Modbus RTU, DNP3, IEC 60870-5-103, IEC 61850.
All the data needed for centralized equipment management from a remote control and monitoring system are available via the communication port:
- in read mode: all measurements, alarms, settings, etc.
- in write mode: breaking device remote control orders, etc.

### Diagnosis

3 types of diagnosis data for improved operation:
- network and machine diagnosis: tripping current, context of the last 5 trips, unbalance ratio, disturbance recording
- switchgear diagnosis: cumulative breaking current, trip circuit supervision, operating time
- diagnosis of the protection unit and additional modules: continuous self-testing, watchdog.

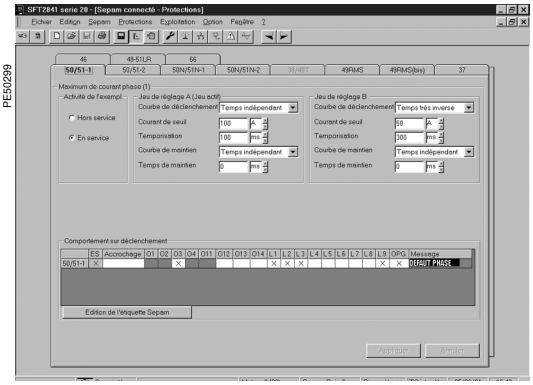
### Control and monitoring

- circuit breaker program logic ready to use, requiring no auxiliary relays or additional wiring
- adaptation of control functions by a logic equation editor
- preprogrammed, customizable alarm messages on UMI.

# Presentation



PE50299


SFT2841 serie 20 - [Sepam connecté - Protections]
Fichier Edition Sepam Protections Exploitation Option Fenêtre ?
46 49-51LR 66
50/51-1 50/51-2 50N/51N-1 50N/51N-2 49RMS 49RMS(bis) 37
Maximum de courant phase (1)
Activité de l'exempl.
Hors service
En service
Jeu de réglage A (Jeu actif)
Courbe de déclenchement
Temps indépendant
Courant de seuil
Temporisation
Courbe de maintien
Temps de maintien
Jeu de réglage B
Temps très inverse
Comportement sur déclenchement
ES Accrochage O1 O2 O3 O4 O11 O12 O13 O14 L1 L2 L3 L4 L5 L6 L7 L8 L9 OPG Message
50/51-1
DEFAUT PHASE
Edition de l'étiquette Sepam
Appliquer
Annuler

*Example of an SFT2841 software screen.*

## User Machine Interface

2 levels of User Machine Interface (UMI) are available according to the user's needs:

■ **basic UMI:**
an economical solution for installations that do not require local operation (run via a remote monitoring and control system)

■ **fixed or remote advanced UMI:**
a graphic LCD display and 9-key keypad are used to display the measurement and diagnosis values, alarm and operating messages and provide access to protection and parameter setting values, for installations that are operated locally..

## Setting and operating software

The **SFT2841** PC software tool gives access to all the Sepam functions, with all the facilities and convenience provided by a Windows type environment.

# Selection table



| | | Substation | | | | | Transformer | | | Motor | Generator |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Protection** | **ANSI code** | **S40 S50** | **S41 S51** | **S42 S52** | **S43 S53** | **S44 S54** | **T40 T50** | **T42 T52** | **M40** | **M41** | **G40** |
| Phase overcurrent | 50/51 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Phase overcurrent cold load pick-up/blocking | CLPU 50/51 | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | | | |
| Voltage-restrained phase overcurrent | 50V/51V | | | | | | | | | | 1 |
| Earth fault, sensitive earth fault | 50N/51N 50G/51G | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Earth fault cold load pick-up/blocking | CLPU 50N/51N | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | 4(4) | | | |
| Breaker failure | 50BF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Negative sequence/unbalance | 46 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Broken conductor | 46 BC | 1(4) | 1(4) | 1(4) | 1(4) | 1(4) | 1(4) | 1(4) | | | |
| Directional phase overcurrent | 67 | | | 2 | | | | 2 | | | |
| Directional earth fault | 67N/67NC | | 2 | 2 | 2 | | | 2 | | 2 | |
| Directional active overpower | 32P | | 1 | 1 | 1 | | | | | 1 | 1 |
| Directional reactive overpower | 32Q/40 | | | | | | | | | 1 | 1 |
| Thermal overload | 49RMS | | | | | | 2 | 2 | 2 | 2 | 2 |
| Phase undercurrent | 37 | | | | | | | | 1 | 1 | |
| Excessive starting time, locked rotor | 48/51LR/14 | | | | | | | | 1 | 1 | |
| Starts per hour | 66 | | | | | | | | 1 | 1 | |
| Positive sequence undervoltage | 27D | | | | | | | | 2 | 2 | |
| Remanent undervoltage | 27R | | | | | | | | 1 | 1 | |
| Undervoltage (3) | 27/27S | 2 | 2 | 2 | | 2 | 2 | 2 | 1 | 2 | 2 |
| Overvoltage (3) | 59 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 |
| Neutral voltage displacement | 59N | 2 | 2 | 2 | | | 2 | 2 | | 2 | 2 |
| Negative sequence overvoltage | 47 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 |
| Overfrequency | 81H | 2 | 2 | 2 | | | 2 | 2 | | 2 | 2 |
| Underfrequency | 81L | 4 | 4 | 4 | | | 4 | 4 | | 4 | 4 |
| Recloser (4 cycles) | 79 | □ | □ | □ | □ | □ | | | | | |
| Temperature monitoring (8 or 16 RTDs, 2 set points per RTD) | 38/49T | | | | | | □ | □ | □ | □ | □ |
| Thermostat/Buchholz | 26/63 | | | | | | □ | □ | | | |
| **Control and monitoring** | | | | | | | | | | | |
| Circuit breaker/contactor control (1) | 94/69 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Latching/acknowledgment | 86 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Logic discrimination | 68 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Switching of groups of settings | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Annunciation | 30 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Logic equation editor | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

■ Standard, □ according to parameter setting and MES114/MES114E/MES114F or MET148-2 input/output module options

***(1)*** *For shunt trip unit or undervoltage trip unit.*

***(2)*** *2 modules possible.*

***(3)*** *Exclusive choice, phase-to-neutral voltage or phase-to-phase voltage for each of the 2 relays.*

***(4)*** *Only for S50, S51, S52, S53, S54 T50, T52 applications.*

***(5)*** *Only for S50, S51, S52, S53, S54 applications.*

# Selection table



| | | Substation | | | | | Transform | | Motor | | Generator |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metering** | **ANSI code** | **S40 S50** | **S41 S51** | **S42 S52** | **S43 S53** | **S44 S54** | **T40 T50** | **T42 T52** | **M40** | **M41** | **G40** |
| Phase current I1, I2, I3 RMS, residual current I0 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Demand current I1, I2, I3, peak demand current IM1, IM2, IM3 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Voltage U21, U32, U13, V1, V2, V3, residual voltage V0 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Positive sequence voltage Vd/rotation direction, negative sequence voltage Vi | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Frequency | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Active, reactive and apparent power P, Q, S<br>Peak demand power PM, QM, power factor | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Calculated active and reactive energy (±W.h, ±var.h) | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Active and reactive energy by pulse counting (±W.h, ±var.h) | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Temperature | | | | | | | □ | □ | □ | □ | □ |
| **Network and machine diagnosis** | | | | | | | | | | | |
| Tripping context | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Tripping current TripI1, TripI2, TripI3, TripI0 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Unbalance ratio/negative-sequence current Ii | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Peak demand negative sequence and positive sequence current ratio[4] | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Phase displacement φ0, φ1, φ2, φ3 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Disturbance recording | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Fault locator[5] | 21FL | ■ | ■ | ■ | ■ | ■ | | | | | |
| Thermal capacity used | | | | | | | ■ | ■ | ■ | ■ | ■ |
| Remaining operating time before overload tripping | | | | | | | ■ | ■ | ■ | ■ | ■ |
| Waiting time after overload tripping | | | | | | | ■ | ■ | ■ | ■ | ■ |
| Running hours counter/operating time | | | | | | | ■ | ■ | ■ | ■ | ■ |
| Starting current and time | | | | | | | | | ■ | ■ | |
| Start inhibit time, number of starts before inhibition | | | | | | | | | ■ | ■ | |
| **Switchgear diagnosis** | | | | | | | | | | | |
| Cumulative breaking current | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Trip circuit supervision | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Number of operations, operating time, charging time | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| CT/VT supervision | 60FL | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Additional modules** | | | | | | | | | | | |
| 8 temperature sensor inputs - MET148-2 module [2] | | | | | | | □ | □ | □ | □ | □ |
| 1 low level analog output - MSA141 module | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Logic inputs/outputs - MES114/MES114E/MES114F module (10I/4O) | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Communication interface - ACE949-2, ACE959, ACE937, ACE969TP-2 or ACE969FO-2, ACE850TP or ACE850FO | | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |

■ Standard, □ according to parameter setting and MES114/MES114E/MES114F or MET148-2 input/output module options

***(1)*** *For shunt trip unit or undervoltage trip unit.*

***(2)*** *2 modules possible.*

***(3)*** *Exclusive choice, phase-to-neutral voltage or phase-to-phase voltage for each of the 2 relays.*

***(4)*** *Only for S50, S51, S52, S53, S54 T50, T52 applications.*

***(5)*** *Only for S50, S51, S52, S53, S54 applications.*

1

## Weight

| | |
|---|---|
| Minimum weight (base unit with basic UMI and without MES114) | 1.4 kg (3.09 lb) |
| Maximum weight (base unit with advanced UMI and MES114) | 1.9 kg (4.19 lb) |

## Analog inputs

| | | | |
|---|---|---|---|
| Current transformer | Input impedance | < 0.02 Ω | |
| 1 A or 5 A CT (with CCA630 or CA634) | Consumption | < 0.02 VA at 1 A | |
| 1 A to 6250 A ratings | | < 0.5 VA at 5 A | |
| | Rated thermal withstand | 4 In | |
| | 1-second overload | 100 In (500 A) | |
| Voltage transformer | Input impedance | > 100 kΩ | |
| 220 V to 250 kV ratings | Input voltage | 100 to 230/√3 V | |
| | Rated thermal withstand | 240 V | |
| | 1-second overload | 480 V | |

## Temperature sensor input (MET148-2 module)

| | | |
|---|---|---|
| Type of sensor | Pt 100 | Ni 100 / 120 |
| Isolation from earth | None | None |
| Current injected in sensor | 4 mA | 4 mA |
| Maximum distance between sensor and module | 1 km (0.62 mi) | |

## Logic inputs

| | | MES114 | MES114E | | MES114F | |
|---|---|---|---|---|---|---|
| Voltage | | 24 to 250 V DC | 110 to 125 V DC | 110 V AC | 220 to 250 V DC | 220 to 240 V AC |
| Range | | 19.2 to 275 V DC | 88 to 150 V DC | 88 to 132 V AC | 176 to 275 V DC | 176 to 264 V AC |
| Frequency | | - | - | 47 to 63 Hz | - | 47 to 63 Hz |
| Typical consumption | | 3 mA | 3 mA | 3 mA | 3 mA | 3 mA |
| Typical switching threshold | | 14 V DC | 82 V DC | 58 V AC | 154 V DC | 120 V AC |
| Input limit voltage | At state 1 | ⩾ 19 V DC | ⩾ 88 V DC | ⩾ 88 V AC | ⩾ 176 V DC | ⩾ 176 V AC |
| | At state 0 | ⩽ 6 V DC | ⩽ 75 V DC | ⩽ 22 V AC | ⩽ 137 V DC | ⩽ 48 V AC |
| Isolation of inputs in relation to other isolated groups | | Enhanced | Enhanced | Enhanced | Enhanced | Enhanced |

## Relay outputs

### Control relay outputs (O1, O2, O3, O11 contacts) (1)

| | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | DC | 24/48 V DC | 127 V DC | 220 V DC | 250 V DC | - |
| | AC (47.5 to 63 Hz) | - | - | - | - | 100 to 240 V AC |
| Continuous current | | 8 A | 8 A | 8 A | 8 A | 8 A |
| Breaking capacity | Resistive load | 8 A / 4 A | 0.7 A | 0.3 A | 0.2 A | - |
| | L/R load < 20 | 6 A / 2 A | 0.5 A | 0.2 A | - | - |
| | L/R load < 40 ms | 4 A / 1 A | 0.2 A | 0.1 A | - | - |
| | Resistive load | - | - | - | - | 8 A |
| | p.f. load > 0.3 | - | - | - | - | 5 A |
| Making capacity | | < 15 A for 200 ms | | | | |
| Isolation of outputs from other isolated groups | | Enhanced | | | | |

### Annunciation relay output (O4, O12, O13, O14 contacts)

| | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | DC | 24/48 V DC | 127 V DC | 220 V DC | 250 V DC | - |
| | AC (47.5 to 63 Hz) | - | - | - | - | 100 to 240 V AC |
| Continuous current | | 2 A | 2 A | 2 A | 2 A | 2 A |
| Breaking capacity | Resistive load | 2 A / 1 A | 0.6 A | 0.3 A | 0.2 A | - |
| | L/R load < 20 ms | 2 A / 1 A | 0.5 A | 0.15 A | - | - |
| | p.f. load > 0.3 | - | - | - | - | 1 A |
| Isolation of outputs from other isolated groups | | Enhanced | | | | |

## Power supply

| | | |
|---|---|---|
| Voltage | 24/250 V DC | 110/240 V AC |
| Range | -20% +10% | -20% +10% (47.5 to 63 Hz) |
| Deactivated consumption (2) | < 6 W | < 6 VA |
| Maximum consumption (2) | < 11 W | < 25 VA |
| Inrush current | < 10 A for 10 ms<br>< 28 A for 100 µs | < 15 A for first half-period |
| Acceptable momentary outages | 20 ms | 20 ms |

## Analog output (MSA141 module)

| | |
|---|---|
| Current | 4 - 20 mA, 0 - 20 mA, 0 - 10 mA |
| Load impedance | < 600 Ω (wiring included) |
| Accuracy | 0.50 % full scale or 0.01 mA |

***(1)*** *Relay outputs (O1, O2, O3, O11 contact) comply with clause 6.7 of standard C37.90, (30 A, 200 ms, 2000 operations).*
***(2)*** *According to configuration.*

# Environmental characteristics



| Electromagnetic compatibility | Standard | Level / Class | Value |
|---|---|---|---|
| **Emission tests** | | | |
| Disturbing field emission | IEC 60255-25 | | |
| | EN 55022 | A | |
| Conducted disturbance emission | IEC 60255-25 | | |
| | EN 55022 | B | |
| **Immunity tests – Radiated disturbances** | | | |
| Immunity to radiated fields | IEC 60255-22-3 | | 10 V/m ; 80 MHz - 1 GHz |
| | IEC 61000-4-3 | III | 10 V/m ; 80 MHz - 2 GHz |
| | ANSI C37.90.2 (2004) | | 20 V/m ; 80 MHz - 1 GHz |
| Electrostatic discharge | IEC 60255-22-2 | | 8 kV air ; 6 kV contact |
| | ANSI C37.90.3 | | 8 kV air ; 4 kV contact |
| Immunity to magnetic fields at network frequency | IEC 61000-4-8 | IV | 30 A/m (continuous) - 300 A/m (13 s) |
| **Immunity tests – Conducted disturbances** | | | |
| Immunity to conducted RF disturbances | IEC 60255-22-6 | | 10 V |
| Immunity to conducted disturbances in common mode from 0 Hz to 150 kHz | IEC 61000-4-16 | III | |
| Fast transient bursts | IEC 60255-22-4 | A or B | 4 kV ; 2.5 kHz / 2 kV ; 5 kHz |
| | IEC 61000-4-4 | IV | 4 kV ; 2.5 kHz |
| | ANSI C37.90.1 | | 4 kV ; 2.5 kHz |
| 1 MHz damped oscillating wave | IEC 60255-22-1 | III | 2.5 kV MC ; 1 kV MD |
| | ANSI C37.90.1 | | 2.5 kV MC and MD |
| 100 kHz damped oscillating wave | IEC 61000-4-12 | | 2 kV MC |
| Surges | IEC 61000-4-5 | III | 2 kV MC ; 1 kV MD |
| Voltage interruptions | IEC 60255-11 | | Series 20: 100 %, 10 ms<br>Series 40: 100 %, 20 ms |
| **Mechanical robustness** | **Standard** | **Level / Class** | **Value** |
| **In operation** | | | |
| Vibrations | IEC 60255-21-1 | 2 | 1 Gn ; 10 Hz - 150 Hz |
| | IEC 60068-2-6 | Fc | 3 Hz - 13.2 Hz ; a = ±1 mm (±0.039 in) |
| | IEC 60068-2-64 | 2M1 | |
| Shocks | IEC 60255-21-2 | 2 | 10 Gn / 11 ms |
| Earthquakes | IEC 60255-21-3 | 2 | 2 Gn (horizontal axes) |
| | | | 1 Gn (vertical axes) |
| **De-energized** | | | |
| Vibrations | IEC 60255-21-1 | 2 | 2 Gn ; 10 Hz - 150 Hz |
| Shocks | IEC 60255-21-2 | 2 | 30 Gn / 11 ms |
| Jolts | IEC 60255-21-2 | 2 | 20 Gn / 16 ms |

# Environmental characteristics



| Climatic withstand | Standard | Level / Class | Value |
|---|---|---|---|
| **In operation** | | | |
| Exposure to cold | IEC 60068-2-1 | Series 20: Ab<br>Series 40: Ad | -25 °C (-13 °F) |
| Exposure to dry heat | IEC 60068-2-2 | Series 20: Bb<br>Series 40: Bd | +70 °C (+158 °F) |
| Continuous exposure to damp heat | IEC 60068-2-3 | Ca | 10 days ; 93 % RH ; 40 °C (104 °F) |
| Temperature variation with specified variation rate | IEC 60068-2-14 | Nb | –25 °C to +70 °C (-13 °F to +158 °F)<br>5°C/min |
| Salt mist | IEC 60068-2-52 | Kb/2 | |
| Influence of corrosion/2 gas test | IEC 60068-2-60 | C | 21 days ; 75 % RH ; 25 °C ; (77 °F)<br>0.5 ppm $H_2S$ ; 1 ppm $SO_2$ |
| Influence of corrosion/4 gas test | IEC 60068-2-60 | | 21 days; 75% RH; 25°C (77°F);<br>0.01 ppm $H_2S$; 0.2 ppm $SO_2$ ;<br>0.2 ppm $NO_2$; ; 0.01 ppm $Cl_2$ |
| | EIA 364-65A | IIIA | 42 days; 75% RH; 30°C (86°F);<br>0.1 ppm $H_2S$; 0.2 ppm $SO_2$ ;<br>0.2 ppm $NO_2$; ; 0.02 ppm $Cl_2$ |
| **In storage (1)** | | | |
| Exposure to cold | IEC 60068-2-1 | Ab | -25 °C (-13 °F) |
| Exposure to dry heat | IEC 60068-2-2 | Bb | +70 °C (+158 °F) |
| Continuous exposure to damp heat | IEC 60068-2-3 | Ca | 56 days ; 93 % RH ; 40 °C (104 °F) |
| **Safety** | **Standard** | **Level / Class** | **Value** |
| **Enclosure safety tests** | | | |
| Front panel tightness | IEC 60529 | IP52 | Other panels closed, except for rear panel IP20 |
| | NEMA | Type 12 with gasket supplied | |
| Fire withstand | IEC 60695-2-11 | | 650 °C (1200 °F) with glow wire |
| **Electrical safety tests** | | | |
| 1.2/50 µs impulse wave | IEC 60255-5 | | 5 kV (2) |
| Power frequency dielectric withstand | IEC 60255-5 | | 2 kV 1 mn (3) |
| **Certification** | | | |
| CE | Harmonized standard:<br>EN 50263 | European directives:<br>■ 89/336/CEE Electromagnetic Comptability (EMC) Directive<br>□ 92/31/CEE Amendment<br>□ 93/68/CEE Amendment<br>■ 73/23/CEE Low Voltage Directive<br>□ 93/68/CEE Amendment | |
| UL - c UL us | UL508 - CSA C22.2 n° 14-95 | | File E212533 |
| CSA | CSA C22.2 n° 14-95 / n° 94-M91 / n° 0.17-00 | | File 210625 |

*(1) Sepam must be stored in its original packing.*
***(2)** Except for communication: 3 kV in common mode and 1 kV in differential mode.*
***(3)** Except for communication: 1 kVrms.*

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# General settings



The general settings define the characteristics of the measurement sensors connected to Sepam and determine the performance of the metering and protection functions used. They are accessed via the SFT2841 setting software General Characteristics tab.

| General settings | | Selection | Setting range |
|---|---|---|---|
| In | Rated phase current (sensor primary current) | 2 or 3 CT 1 A / 5 A | 1 A to 6250 A |
| | | 3 LPCTs | 25 A to 3150 A (1) |
| Ib | Base current, according to rated power of equipment | | 0.2 In to 1.3 In |
| In0 | Rated residual current | Sum of 3 phase currents | See In rated phase current |
| | | CSH120 or CSH200 core balance CT | 2 A, 5 A or 20 A rating |
| | | 1 A/5 A CT | 1 A to 6250 A (In0 = In) |
| | | 1 A/5 A CT<br>Sensitivity x 10 | 0.1 A to 625 A (In0 = In/10) |
| | | Core balance CT + ACE990 (the core balance CT ratio 1/n must be such that $50 \leqslant n \leqslant 1500$) | According to current monitored and use of ACE990 |
| Unp | Rated primary phase-to-phase voltage (Vnp: rated primary phase-to-neutral voltage Vnp = Unp/$\sqrt{3}$) | | 220 V to 250 kV |
| Uns | Rated secondary phase-to-phase voltage | 3 VTs: V1, V2, V3 | 90 V to 230 V in steps of 1 V |
| | | 2 VTs: U21, U32 | 90 V to 120 V in steps of 1 V |
| | | 1 VT: V1 | 90 V to 120 V in steps of 1 V |
| Uns0 | Secondary zero sequence voltage for primary zero sequence voltage Unp/$\sqrt{3}$ | | Uns/3 or Uns/$\sqrt{3}$ |
| | Rated frequency | | 50 Hz or 60 Hz |
| | Integration period (for demand current and peak demand current and power) | | 5, 10, 15, 30, 60 mn |
| | Pulse-type accumulated energy meter | Increments active energy | 0.1 kW.h to 5 MW.h |
| | | Increments reactive energy | 0.1 kvar.h to 5 Mvar.h |

***(1)*** *In values for LPCT, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.*

# Characteristics



| Functions | | Measurement range | Accuracy (1) | MSA141 | Saving |
|---|---|---|---|---|---|
| **Metering** | | | | | |
| Phase current | | 0.1 to 40 In (3) | ±0.5 % | ■ | |
| Residual current | Calculated | 0.1 to 40 In | ±1 % | ■ | |
| | Measured | 0.1 to 20 In0 | ±1 % | ■ | |
| Demand current | | 0.1 to 40 In | ±0.5 % | | |
| Peak demand current | | 0.1 to 40 In | ±0.5 % | | □ |
| Phase-to-phase voltage | | 0.06 to 1.2 Unp | ±0.5 % | ■ | |
| Phase-to-neutral voltage | | 0.06 to 1.2 Vnp | ±0.5 % | ■ | |
| Residual voltage | | 0.04 to 3 Vnp | ±1 % | | |
| Positive sequence voltage | | 0.05 to 1.2 Vnp | ±2 % | | |
| Negative sequence voltage | | 0.05 to 1.2 Vnp | ±2 % | | |
| Frequency | | 25 to 65 Hz | ±0.02 Hz | ■ | |
| Active power | | 0.015 Sn(2) to 999 MW | ±1 % | ■ | |
| Reactive power | | 0.015 Sn(2) to 999 Mvar | ±1 % | ■ | |
| Apparent power | | 0.015 Sn(2) to 999 MVA | ±1 % | ■ | |
| Peak demand active power | | 0.015 Sn(2) to 999 MW | ±1 % | | □ |
| Peak demand reactive power | | 0.015 Sn(2) to 999 Mvar | ±1 % | | □ |
| Power factor | | -1 to +1 (CAP/IND) | ±1 % | | |
| Calculated active energy | | 0 to $2.1.10^8$ MW.h | ±1 % ±1 digit | | □ |
| Calculated reactive energy | | 0 to $2.1.10^8$ Mvar.h | ±1 % ±1 digit | | □ |
| Temperature | | -30 to +200 °C<br>or -22 to +392 °F | ±1 °C from +20 to +140 °C | ■ | |
| **Network diagnosis assistance** | | | | | |
| Tripping context | | | | | □ |
| Phase tripping current | | 0.1 to 40 In | ±5 % | | □ |
| Earth fault tripping current | | 0.1 to 20 In0 | ±5 % | | □ |
| Negative sequence / unbalance | | 10 to 500 % of Ib | ±2 % | | |
| Peak demand negative sequence and positive sequence current ratio | | 1 to 500 % | ±2 % | | |
| Phase displacement φ0 (between V0 and I0) | | 0 to 359° | ±2° | | |
| Phase displacement φ1, φ2, φ3 (between V and I) | | 0 to 359° | ±2° | | |
| Disturbance recording | | | | | □ |
| Fault locator | Fault location | 0 to 99.99 km<br>or 0 to 62.13 mi | ±2 % | | |
| | Fault resistance | 0 to 999.9 Ω | ±10 % | | |
| **Machine operating assistance** | | | | | |
| Thermal capacity used | | 0 to 800 %<br>(100 % for I phase = Ib) | ±1 % | ■ | □ |
| Remaining operating time before overload tripping | | 0 to 999 mn | ±1 mn | | |
| Waiting time after overload tripping | | 0 to 999 mn | ±1 mn | | |
| Running hours counter / operating time | | 0 to 65535 hours | ±1 % or ±0.5 h | | □ |
| Starting current | | 1.2 Ib to 24 In | ±5 % | | □ |
| Starting time | | 0 to 300 s | ±300 ms | | □ |
| Number of starts before inhibition | | 0 to 60 | 1 | | |
| Start inhibit time | | 0 to 360 mn | ±1 mn | | |
| Cooling time constant | | 5 to 600 mn | ±5 mn | | |
| **Switchgear diagnosis assistance** | | | | | |
| Cumulative breaking current | | 0 to 65535 $kA^2$ | ±10 % | | □ |
| Number of operations | | 0 to $4.10^9$ | 1 | | □ |
| Operating time | | 20 to 100 ms | ±1 ms | | □ |
| Charging time | | 1 to 20 s | ±0.5 s | | □ |

■ *available on MSA141 analog output module, according to setup.*
□ *saved in the event of auxiliary supply outage.*
***(1)*** *Typical accuracy, see details on subsequent pages.*
***(2)*** *Sn: apparent power, = √3.Unp.In.*
***(3)*** *Measurement up to 0.02 In for information purpose.*

# Phase current
# Residual current



## Phase current

### Operation

This function gives the RMS value of the phase currents:
- I1: phase 1 current
- I2: phase 2 current
- I3: phase 3 current.

It is based on RMS current measurement and takes into account harmonics up to number 17.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | |
|---|---|
| Measurement range | 0.1 to 1.5 In (1) |
| Unit | A or kA |
| Accuracy | ±0.5 % typical (2)<br>±2 % from 0.3 to 1.5 In<br>±5 % if < 0.3 In |
| Display format (3) | 3 significant digits |
| Resolution | 0.1 A |
| Refresh interval | 1 second (typical) |

***(1)*** *In rated current set in the general settings.*
***(2)*** *At In, in reference conditions (IEC 60255-6).*
***(3)*** *Display of values: 0.02 to 40 In.*

## Residual current

### Operation

This operation gives the RMS value of the residual current I0.
It is based on measurement of the fundamental component.

### Readout

The residual current measured (I0), and the residual current calculated by the sum of the phase currents (IoΣ) may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | | |
|---|---|---|
| Measurement range | | |
| Connection to 3 phase CTs: | | 0.1 to 1.5 In0 (1) |
| Connection to 1 CT | | 0.1 to 1.5 In0 (1) (3) |
| Connection to core balance CT with ACE990 | | 0.1 to 1.5 In0 (1) |
| Connection to CSH residual current sensor | 2 A rating | 0.2 to 3 A (3) |
| | 5 A rating | 0.5 to 7.5 A (3) |
| | 20 A rating | 2 to 30 A (3) |
| Unit | | A or kA |
| Accuracy (2) | | ±1 % typical at In0<br>±2 % from 0.3 to 1.5 In0<br>±5 % if < 0.3 In0 |
| Display format | | 3 significant digits |
| Resolution | | 0.1 A |
| Refresh interval | | 1 second (typical) |

***(1)*** *In0 rated current set in the general settings.*
***(2)*** *In reference conditions (IEC 60255-6), excluding sensor accuracy.*
***(3)*** *In0 = InCT or In0 = InCT/10 according to setting.*

# Average current and peak demand currents



## Operation

This function gives:
- the average RMS current for each phase that has been obtained for each integration interval
- the greatest average RMS current value for each phase that has been obtained since the last reset.

The values are refreshed after each "integration interval", an interval that may be set from 5 to 60 mn, and are saved in the event of a power failure.

## Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

## Resetting to zero

- press the clear key on the advanced UMI display unit when a peak demand current is displayed
- via the clear command in the SFT2841 software
- via the communication link (remote control order TC6).

## Characteristics

| | |
|---|---|
| Measurement range | 0.1 to 1.5 In (1) |
| Unit | A or kA |
| Accuracy | ±0.5 % typical (2)<br>±2 % from 0.3 to 1.5 In<br>±5 % if < 0.3 In |
| Display format (3) | 3 significant digits |
| Resolution | 0.1 A |
| Integration period | 5, 10, 15, 30, 60 minutes |

***(1)*** *In rated current set in the general settings.*
***(2)*** *At In, in reference conditions (IEC 60255-6).*
***(3)*** *Display of values: 0.02 to 40 In.*

## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC6 | BO12 | - | MSTA1.RsMaxA.ctlVal |

# Phase-to-phase voltage
# Phase-to-neutral voltage



## Phase-to-phase voltage

### Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-phase voltages (according to voltage sensor connections):

- U21: voltage between phases 2 and 1
- U32: voltage between phases 3 and 2
- U13: voltage between phases 1 and 3.

It is based on measurement of the fundamental component.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | |
|---|---|
| Measurement range | 0.06 to 1.2 Unp (1) |
| Unit | V or kV |
| Accuracy | ±0.5 % typical (2)<br>±1 % from 0.5 to 1.2 Unp<br>±2 % from 0.06 to 0.5 Unp |
| Display format | 3 significant digits |
| Resolution | 1 V |
| Refresh interval | 1 second (typical) |

***(1)*** *Un nominal rating set in the general settings.*
***(2)*** *At Unp, in reference conditions (IEC 60255-6).*

## Phase-to-neutral voltage

### Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-neutral voltages:

- V1: phase 1 phase-to-neutral voltage
- V2: phase 2 phase-to-neutral voltage
- V3: phase 3 phase-to-neutral voltage.

It is based on measurement of the fundamental component.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | |
|---|---|
| Measurement range | 0.06 to 1.2 Vnp (1) |
| Unit | V or kV |
| Accuracy | ±0.5 % typical (2)<br>±1 % from 0.5 to 1.2 Vnp<br>±2 % from 0.06 to 0.5 Vnp |
| Display format | 3 significant digits |
| Resolution | 1 V |
| Refresh interval | 1 second (typical) |

***(1)*** *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/$\sqrt{3}$).*
***(2)*** *At Vnp in reference conditions (IEC 60255-6).*

# Residual voltage
# Positive sequence voltage



## Residual voltage

### Operation

This function gives the value of the residual voltage V0 = (V1 + V2 + V3).
V0 is measured:
- by taking the internal sum of the 3 phase voltages
- by an open star / delta VT.

It is based on measurement of the fundamental component.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0.04 Vnp to 3 Vnp (1) |
| Unit | V or kV |
| Accuracy | ±1 % from 0.5 to 3 Vnp<br>±2 % from 0.05 to 0.5 Vnp<br>±5 % from 0.04 to 0.05 Vnp |
| Display format | 3 significant digits |
| Resolution | 1 V |
| Refresh interval | 1 second (typical) |

***(1)*** *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/√3).*

## Positive sequence voltage

### Operation

This function gives the calculated value of the positive sequence voltage Vd.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0.05 to 1.2 Vnp (1) |
| Unit | V or kV |
| Accuracy | ±2 % at Vnp |
| Display format | 3 significant digits |
| Resolution | 1 V |
| Refresh interval | 1 second (typical) |

***(1)*** *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/√3).*

# Negative sequence voltage Frequency



## Negative sequence voltage

### Operation

This function gives the calculated value of the negative sequence voltage Vi.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0.05 to 1.2 Vnp (1) |
| Unit | V or kV |
| Accuracy | ±2 % at Vnp |
| Display format | 3 significant digits |
| Resolution | 1 V |
| Refresh interval | 1 second (typical) |

***(1)*** *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/√3).*

## Frequency

### Operation

This function gives the frequency value.
Frequency is measured via the following:
- based on U21, if only one phase-to-phase voltage is connected to the Sepam
- based on positive sequence voltage, if the Sepam includes U21 and U32 measurements.

Frequency is not measured if:
- the voltage U21 or positive sequence voltage Vd is less than 40 % of Un
- the frequency is outside the measurement range.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | | |
|---|---|---|
| Rated frequency | | 50 Hz, 60 Hz |
| Range | | 25 to 65 Hz |
| Accuracy (1) | | ±0.02 Hz |
| Display format | | 3 significant digits |
| Resolution | On SFT2841 | 0.01 Hz |
| | On Sepam display | 0.1 Hz |
| Refresh interval | | 1 second (typical) |

***(1)*** *At Unp in reference conditions (IEC 60255-6).*

# Active, reactive and apparent power

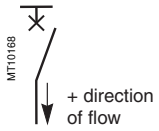


## Operation

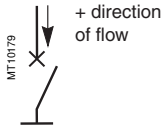
This function gives the power values:
- P active power = $\sqrt{3}$ .U.I cos φ
- Q reactive power = $\sqrt{3}$ .U.I.sin φ
- S apparent power = $\sqrt{3}$ .U.I.

The function measures the active and reactive power in 3-wire 3-phase arrangements by means of the two wattmeter method. The powers are obtained based on the phase-to-phase voltages U21 and U32 and the phase currents I1 and I3.
When only the voltage U21 is connected, P and Q are calculated assuming that the system voltage is balanced.

According to standard practice, it is considered that:
- for the outgoing circuit (1):
  - power exported by the busbar is positive
  - power supplied to the busbar is negative




- for the incoming circuit (1):
  - power supplied to the busbar is positive
  - power exported by the busbar is negative.




## Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

***(1)*** *Choice to be set in the general settings.*

## Characteristics

| | **Active power P** | **Reactive power Q** |
|---|---|---|
| Measurement range | ±(1.5 % Sn at 999 MW) (1) | ±(1.5 % Sn at 999 Mvar) (1) |
| Unit | kW, MW | kvar, Mvar |
| Accuracy | ±1 % typical (2) | ±1 % typical (2) |
| Display format | 3 significant digits | 3 significant digits |
| Resolution | 0.1 kW | 0.1 kvar |
| Refresh interval | 1 second (typical) | 1 second (typical) |

| | **Apparent power S** |
|---|---|
| Measurement range | 1.5 % Sn at 999 MVA (1) |
| Unit | kVA, MVA |
| Accuracy | ±1 % typical (2) |
| Display format | 3 significant digits |
| Resolution | 0.1 kVA |
| Refresh interval | 1 second (typical) |

***(1)*** *Sn = $\sqrt{3}$ Unp.In.*
***(2)*** *At In, Unp, cos φ > 0.8 in reference conditions (IEC 60255-6).*

# Peak demand active and reactive power Power factor (cos φ)



## Peak demand active and reactive power

### Operation

This function gives the greatest average active or reactive power value since the last reset.

The values are refreshed after each "integration interval", an interval that may be set from 5 to 60 mn (common interval with peak demand phase currents). The values are saved in the event of a power failure.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Resetting to zero

- press the clear key on the advanced UMI display unit when a peak demand is displayed
- via the **"clear"** command in the SFT2841 software
- via the communication link (remote control order TC6).

### Characteristics

| | Active power P | Reactive power Q |
|---|---|---|
| Measurement range | ±(1.5 % Sn at 999 MW) (1) | ±(1.5 % Sn at 999 Mvar) (1) |
| Unit | kW, MW | kvar, Mvar |
| Accuracy | ±1 % typical (2) | ±1 % typical (2) |
| Display format | 3 significant digits | 3 significant digits |
| Resolution | 0.1 kW | 0.1 kvar |
| Integration interval | 5, 10, 15, 30, 60 mn | 5, 10, 15, 30, 60 mn |

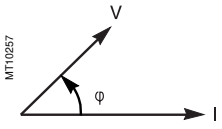
***(1)*** *Sn = $\sqrt{3}$ Unp.In.*

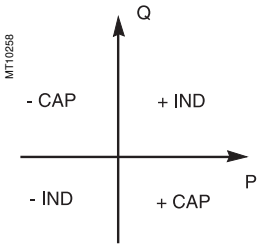
***(2)*** *At In, Unp, cos φ > 0.8 in reference conditions (IEC 60255-6).*

### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC6 | BO12 | - | MSTA1.RsMaxA.ctlVal |

## Power factor (cos φ)




### Operation

The power factor is defined by:

$$\cos\varphi = P / \sqrt{P^2 + Q^2}$$

It expresses the phase displacement between the phase currents and phase-to-neutral voltages.

The + and - signs and **IND** (inductive) and **CAP** (capacitive) indications give the direction of power flow and the type of load.

### Readout

The measurement may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | -1 to 1 IND/CAP |
| Accuracy (1) | ±0.01 typical |
| Display format | 3 significant digits |
| Resolution | 0.01 |
| Refresh interval | 1 second (typical) |

***(1)*** *At In, Unp, cos φ > 0.8 in reference conditions (IEC 60255-6).*

## Accumulated active and reactive energy

### Operation

This function gives the following for the active and reactive energy values:
- accumulated energy conveyed in one direction
- accumulated energy conveyed in the other direction.

It is based on measurement of the fundamental component.
The accumulated energy values are saved in the event of a power failure.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | Active energy | Reactive energy |
|---|---|---|
| Metering capacity | 0 to 2.1 $10^8$ MW.h | 0 to 2.1 $10^8$ Mvar.h |
| Unit | MW.h | Mvar.h |
| Accuracy | ±1 % typical (1) | ±1 % typical (1) |
| Display format | 10 significant digits | 10 significant digits |
| Resolution | 0.1 MW.h | 0.1 Mvar.h |

*(1) At In, Unp, cos φ > 0.8 in reference conditions (IEC 60255-6).*

## Accumulated active and reactive energy by pulse metering

### Operation

This function is used for energy metering via logic inputs. Energy incrementing is associated with each input (one of the general parameters to be set). Each input pulse increments the meter. 4 inputs and 4 accumulated energy metering options are available:
- positive and negative active energy
- positive and negative reactive energy.

The accumulated active and reactive energy values are saved in the event of a power failure.

### Readout

- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | Active energy | Reactive energy |
|---|---|---|
| Metering capacity | 0 to 2.1 $10^8$ MW.h | 0 to 2.1 $10^8$ Mvar.h |
| Unit | MW.h | Mvar.h |
| Display format | 10 significant digits | 10 significant digits |
| Resolution | 0.1 MW.h | 0.1 Mvar.h |
| Increment | 0.1 kW.h to 5 MW | 0.1 kvar.h to 5 Mvar.h |
| Impulse | 15 ms min. | 15 ms min. |

# Temperature



## Operation

This function gives the temperature value measured by resistance temperature detectors (RTDs):
- platinum Pt100 (100 Ω at 0 °C or 32 °F) in accordance with the IEC 60751 and DIN 43760 standards
- nickel 100 Ω or 120 Ω (at 0 °C or 32 °F).

Each RTD channel gives one measurement:
tx = RTD x temperature.
The function also indicates RTD faults:
- RTD disconnected (tx > 205 °C or t > 401 °F)
- RTD shorted (tx < -35 °C or t < -31 °F).

In the event of a fault, display of the value is inhibited.
The associated monitoring function generates a maintenance alarm.

## Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key, in °C or in °F
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

## Characteristics

| | | |
|---|---|---|
| Range | -30 °C to +200 °C | -22 °F to +392 °F |
| Resolution | 1 °C | 1 °F |
| Accuracy (1) | ±1 °C from +20 to +140 °C | ±1.8 °F from +68 °F to +284 °F |
| | ±2 °C from -30 to +20 °C | ±3.6 °F from -22 °F to +68 °F |
| | ±2 °C from +140 to +200 °C | ±3.6 °F from +284 °F to +392 °F |
| Refresh interval | 5 seconds (typical) | |

**Accuracy derating according to wiring:**
See "Installation of MET148-2 module" page 228.

# Tripping context
# Tripping current



## Tripping context

### Operation

This function gives the values of physical units at the time of tripping to enable analysis of the cause of the fault.
The values available, accessible via the advanced UMI or the SFT2841 software tool are as follows:

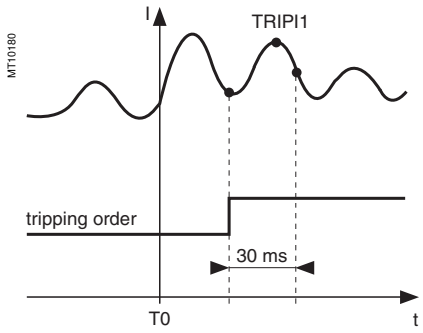
- tripping currents
- residual current measured on I0 input
- residual current calculated on the sum of the phase currents
- positive sequence current
- negative sequence current
- phase-to-phase voltages
- phase-to-neutral voltages
- residual voltage
- positive sequence voltage
- negative sequence voltage
- frequency
- active power
- reactive power
- fault location
- fault resistance
- faulty phase(s).

The values corresponding to the last five trips are stored with the date and time of the trip. They are saved in the event of a power failure.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.




*Tripping current (TRIPI1) acquisition.*

## Tripping current

### Operation

This function gives the RMS value of currents at the prospective time of the last trip:

- TRIPI1: phase 1 current
- TRIPI2: phase 2 current
- TRIPI3: phase 3 current.

It is based on measurement of the fundamental component.
This measurement is defined as the maximum RMS value measured during a 30 ms interval after the activation of the tripping contact on output O1.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0.1 to 40 In (1) |
| Unit | A or kA |
| Accuracy | ±5 % ±1 digit |
| Display format | 3 significant digits |
| Resolution | 0.1 A |

***(1)*** *In rated current set in the general settings.*

# Negative sequence / unbalance Peak demand negative sequence and positive sequence current ratio



## Negative sequence / unbalance

### Operation

This function gives the negative sequence component: **T = Ii/Ib**
The negative sequence current is determined based on the phase currents:
- 3 phases

$$\vec{Ii} = \frac{1}{3} \times (\vec{I1} + a^2\vec{I2} + a\vec{I3})$$

with $a = e^{j\frac{2\pi}{3}}$

- 2 phases

$$\vec{Ii} = \frac{1}{\sqrt{3}} \times (\vec{I1} - a^2\vec{I3})$$

with $a = e^{j\frac{2\pi}{3}}$

These 2 formulas are equivalent when there is no earth fault.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the Σ key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 10 to 500 % |
| Unit | % Ib |
| Accuracy | ±2 % |
| Display format | 3 significant digits |
| Resolution | 1 % |
| Refresh interval | 1 second (typical) |

## Peak demand negative sequence and positive sequence current ratio

### Operation

This peak demand meter is used as an aid to setting the set point for the broken conductor detection protection function (ANSI code 46BC).
It provides the highest value of the negative sequence and positive sequence current ratio Ii/Id since the last reset.
A phase current measurement with 3 CTs is mandatory for this calculation.
The negative sequence current is given by:

$$\vec{Ii} = \frac{1}{3} \times (\vec{I1} + a^2\vec{I2} + a\vec{I3})$$

The positive sequence current is given by:

$$\vec{Id} = \frac{1}{3} \times (\vec{I1} + a\vec{I2} + a^2\vec{I3})$$

where $a = e^{j\frac{2\pi}{3}}$

### Readout

The measurements may be accessed via:
- the display of a PC with the SFT2841 software
- the Modbus communication link.

### Resetting to zero

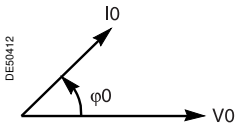
Only via the "Reset Ii/ Id peak demand meter" command on the "network diagnosis" display of the SFT2841 software.

### Characteristics

| | |
|---|---|
| Measuring range | 1 to 500% |
| Accuracy | ±2% |
| Resolution | 1% |
| Refresh period | 1 second (typical) |

# Phase displacement φ0
# Phase displacement φ1, φ2, φ3






*Phase displacement φ0.*

## Phase displacement φ0

### Operation

This function give the phase displacement measured between the residual voltage and residual current in the trigonometric sense (see diagram).
The measurement is useful during commissioning to check that the directional earth fault protection unit is connected correctly.

**Two values are available:**

- φ0, angle with measured I0
- φ0Σ, angle with I0 calculated by sum of phase currents.

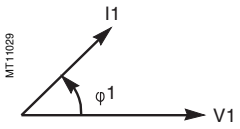
### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 359° |
| Resolution | 1° |
| Accuracy | ±2° |
| Refresh interval | 2 seconds (typical) |




*Phase displacement φ1.*

## Phase displacement φ1, φ2, φ3

### Operation

This function gives the phase displacement between the V1, V2, V3 voltages and I1, I2, I3 currents respectively, in the trigonometric sense (see diagram). The measurements are used when Sepam is commissioned to check that the voltage and current inputs are wired correctly. It does not operate when only the U21 voltage is connected to Sepam.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 359° |
| Resolution | 1° |
| Accuracy | ±2° |
| Refresh interval | 2 seconds (typical) |

# Disturbance recording



## Operation

This function is used to record analog signal and logical states.
Record storage is activated according to parameter setting by a triggering event (see Control and monitoring functions - Disturbance recording triggering).
The stored event begins before the triggering event and continues afterwards.
The record comprises the following information:
- values sampled from the different signals
- date
- characteristics of the recorded channels.

The duration and number of records may be set using the SFT2841 software tool.
The files are recorded in FIFO (First In First Out) type shift storage. When the maximum number of records is reached, the oldest record is erased when a new record is triggered.
The disturbance records are saved for a minimum of 48 hours and typically for approximately 100 hours when the Sepam is switched off.

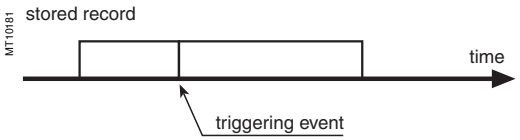
**Transfer**

Files may be transferred locally or remotely:
- locally: using a PC which is connected to the front panel connector and has the SFT2841 software tool
- remotely: using a software tool specific to the remote monitoring and control system.

**Recovery**

The signals are recovered from a record by means of the SFT2826 software tool.

## Principle




## Characteristics

| | |
|---|---|
| Record content | Set-up file:<br>date, channel characteristics, measuring chain transformer ratio<br>Sample file:<br>12 values per period/recorded signal |
| Analog signals (2)<br>recorded | 4 current channels (I1, I2, I3, I0)<br>3 voltage channels (V1, V2, V3 or U21, U32, V0) |
| Logical states recorded | 10 logic inputs, logic outputs O1 to O4, pick-up,<br>1 data item configurable by the logic equation editor |
| Number of records stored | 1 to 19 |
| Total duration of a record | 1 s to 10 s<br>The total records plus one should not exceed<br>20 s at 50 Hz and 16 s at 60 Hz.<br>Examples (at 50 Hz):<br>1 x 10 s record<br>3 x 5 s records<br>19 x 1 s records |
| Periods before triggering event (1) | 0 to 99 periods |
| File format | COMTRADE 97 |

***(1)*** *According to parameter setting with the SFT2841 software and factory-set to 36 periods.*
***(2)*** *According to the type of sensors.*

# Fault locator
## ANSI code 21FL



### Description

The Fault locator function calculates the location and resistance of a presumed fault in a medium-voltage network.

The fault location is calculated for faults downstream of the point where the protection relay is installed, typically on the incoming feeder of an installation on a network comprising several feeders.

■ The single-phase fault locator is associated with the ANSI 50N/51N and ANSI 67N protection functions.

■ The multi-phase fault locator is associated with the ANSI 50/51 and ANSI 67 protection functions.

Only the protection function units configured for circuit breaker tripping can activate the Fault locator function.

After calculation, the following data is recorded in the tripping context:

■ fault location (in km or in mi)

■ fault resistance (in Ω)

■ faulty phase(s)

This data may be accessed with the other measurements in the tripping contexts via:

■ the display of a PC with the SFT2841 software

■ the communication link.

See “Tripping context Tripping current”, page 31.

### Field of application

The Fault locator function is suitable for:

■ medium-voltage networks:

□ overhead, made up of 100% overhead lines

□ or mixed, made up of 0 to 30% underground cables and 70 to 100% overhead lines

■ with neutral to earth connection:

□ direct

□ with earthing resistor and fault current > 150 A

□ with R-X impedance in series, with ratio R/X > 3

The Fault locator function gives incorrect results when it is applied to underground networks or networks with an isolated or compensated neutral.

The Fault locator function can only be activated if the rated primary voltage (Unp) is set between 5.5 kV and 36 kV.

### Operation

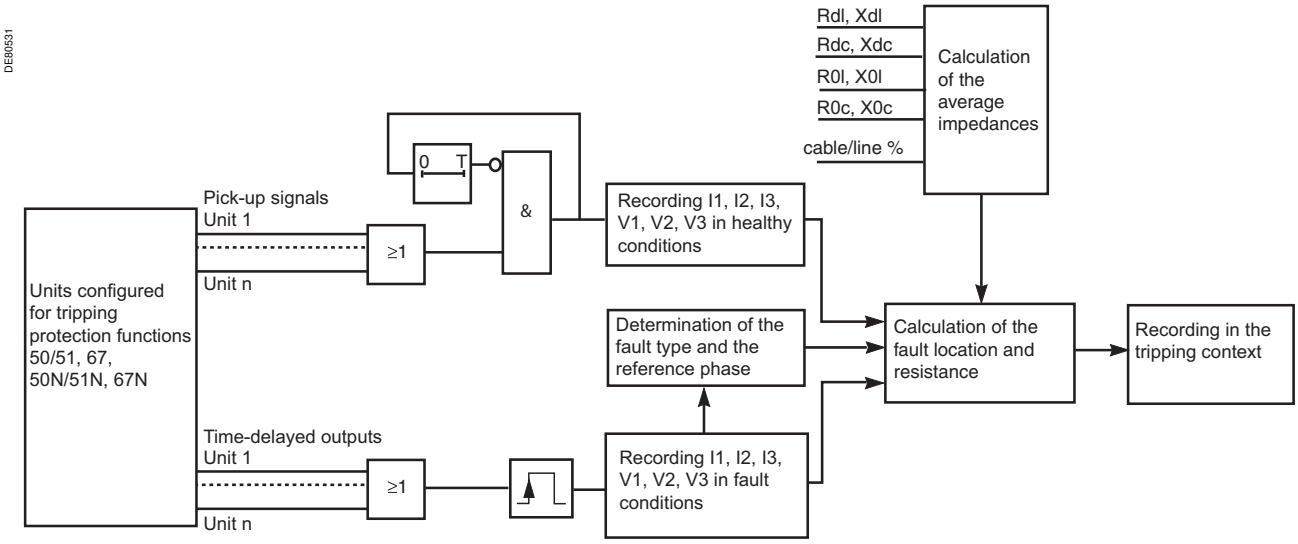
The fault location is calculated using symmetrical components. These are calculated using the values of the 3 currents and 3 phase-to-earth voltages:

■ recorded during healthy operation, before the appearance of the fault

■ recorded in steady state fault conditions.

The main assumption of this calculation relies on simplification of the diagram of the feeder monitored via the protection. The tree diagram comprising a variety of conductors and loads is replaced by an equivalent simplified diagram which contains no more than one type of conductor and one load connected at the end of the line. The function determines the type of fault and the phases affected by the fault, then calculates the fault location using a patented algorithm.

### Block diagram



### Protection setting parameters

The protection setting parameters are:
■ time delay T indicating the time it takes to establish healthy conditions after the last instantaneous "pick-up" signal.
Time delay T avoids having to record the values measured in fault conditions as healthy values during, for example, a circuit breaker reclosing cycle.
■ the percentage of cable in the relevant feeder
■ symmetrical impedances of conductors in /km or in /mi:
□ Rdl, Xdl: resistance and reactance per unit length of the positive sequence diagram of overhead line conductors
□ Rdc, Xdc: resistance and reactance per unit length of the positive sequence diagram of underground cable conductors
□ R0l, X0l: resistance and reactance per unit length of the zero sequence diagram of overhead line conductors
□ R0c, X0c: resistance and reactance per unit length of the zero sequence diagram of underground cable conductors.

Average impedance values are given in the table below. They were calculated taking the average of the IEC 60909 answers and the calculations statistics.

| **Average impedance values depending on the type of conductor in** Ω/km (Ω/mi) | | | | |
|---|---|---|---|---|
| **Cable** | **Rdc** | **Xdc** | **R0c** | **X0c** |
| Multi-core | 0.39 (0.63) | 0.14 (0.225) | 2 (3.22) | 0.4 (0.64) |
| Single-phase | 0.06 (0.1) | 0.11 (0.18) | 0.99 (1.6) | 1.41 (1.83) |
| **Line** | **Rdl** | **Xdl** | **R0l** | **X0l** |
| Single-core | 0.68 (1.1) | 0.372 (0.6) | 0.828 (1.33) | 1.696 (2.73) |

### Characteristics

| | |
|---|---|
| **Time delay T** | |
| Setting | 1 s to 99 min |
| **Percentage of cable in the relevant feeder** | |
| Setting | 0 to 30% |
| **Symmetrical impedance of conductors** | |
| Positive sequence resistance of Rdl lines | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Positive sequence reactance of Xdl lines | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Positive sequence resistance of Rdc cables | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Positive sequence reactance of Xdc cables | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Zero sequence resistance of R0l lines | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Zero sequence reactance of X0l lines | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Zero sequence resistance of R0c cables | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |
| Zero sequence reactance of X0c cables | 0.001 to 10 Ω/km or 0.0016 to 16.1 Ω/mi |

### Indicative performance

The relative error on the fault location is calculated
■ in relation to the longest path on the feeder:

$$\varepsilon = \frac{Dreal - Destimated}{Dlongest} 100\ \%$$

■ in the following conditions:
□ load supplied on the feeder less than 4 MVA
□ fault resistance less than 150 Ω.

| **Accuracy of calculation of the single-phase fault location** | |
|---|---|
| **Feeder type** | **Typical error** |
| Overhead | ±1.02% |
| Mixed (30% cable) | ±7% |
| **Accuracy of calculation of the multi-phase fault location** | |
| **Feeder type** | **Typical error** |
| Overhead | ±0.73% |
| Mixed (30% cable) | ±2.73% |

# Thermal capacity used Cooling time constant



## Thermal capacity used

### Operation

The thermal capacity used is calculated by the thermal protection function.
The thermal capacity used is related to the load. The thermal capacity used measurement is given as a percentage of the rated thermal capacity.

### Saving of thermal capacity used

The thermal capacity used is saved in the event of a Sepam power cut. The saved value is used again after a Sepam power outage.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 800 % |
| Unit | % |
| Display format | 3 significant digits |
| Resolution | 1 % |
| Refresh interval | 1 second (typical) |

## Cooling time constant

### Operation

The cooling time constant T2 of the equipment being monitored (transformer, motor or generator) is estimated by the thermal overload protection function.
It is calculated each time the equipment operates for a sufficiently long period, followed by a shutdown (I < 0.1 Ib) and temperature stabilization phase.
The calculation is based on the temperature measured by RTDs 1, 2 and 3 (stator sensors for motors and generators) or by RTDs 1, 3 and 5 (primary winding sensors for transformers). For greater accuracy, it is advisable for the ambient temperature to be measured by RTD 8.
If "other applications" is chosen in the RTD assignment table, T2 is not estimated.
Two measurements are available, one for each thermal operating rate of the monitored equipment.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 5 to 600 mn |
| Unit | mn |
| Resolution | 1 mn |
| Accuracy | ±5 % |
| Display format | 3 significant digits |

# Operating time before tripping Waiting time after tripping



## Remaining operating time before overload tripping

### Operation

The time is calculated by the thermal protection function. It depends on the thermal capacity used.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 999 mn |
| Unit | mn |
| Display format | 3 significant digits |
| Resolution | 1 mn |
| Refresh interval | 1 second (typical) |

## Waiting time after overload tripping

### Operation

The time is calculated by the thermal protection function. It depends on the thermal capacity used.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 999 mn |
| Unit | mn |
| Display format | 3 significant digits |
| Resolution | 1 mn |
| Refresh period | 1 second (typical) |

# Running hours counter and operating time
# Starting current and starting/ overload time

## Running hours counter and operating time

The counter gives the running total of time during which the protected device (motor, generator or transformer) has been operating (I > 0.1 Ib). The initial counter value may be modified using the SFT2841 software.
The counter is saved in the event of an auxiliary power failure.

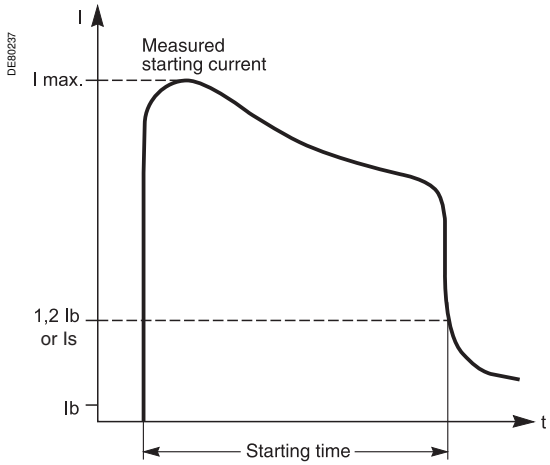
### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Range | 0 to 65535 |
| Unit | hours |

## Starting current and starting/overload time




### Operation

The starting time is defined as follows:
- If the locked rotor/excessive starting time protection (ANSI code 48/51LR) is active, the starting time is the time separating the moment when one of the 3 phase currents exceeds Is and the moment when the 3 currents drop back below Is, Is being the value of the current set point for protection function 48/51LR.
- If the locked rotor/excessive starting time protection (ANSI code 48/51LR) is not active, the starting time is the time separating the moment when one of the 3 phase currents exceeds 1.2 Ib and the moment when the 3 currents drop back below 1.2 Ib.

The maximum phase current obtained during this time corresponds to the starting/ overload current.
Both values are saved in the event of an auxiliary power failure.

### Readout

The measurements may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | | |
|---|---|---|
| **Starting/overload time** | | |
| Measurement range | | 0 to 300 s |
| Unit | | s or ms |
| Display format | | 3 significant digits |
| Resolution | | 10 ms or 1 digit |
| Refresh interval | | 1 second (typical) |
| **Starting/overload current** | | |
| Measurement range | 48/51LR active | Is to 24 In (1) |
| | 48/51LR inactive | 1.2 Ib to 24 In (1) |
| Unit | | A or kA |
| Display format | | 3 significant digits |
| Resolution | | 0.1 A or 1 digit |
| Refresh interval | | 1 second (typical) |

***(1)*** *Or 65.5 kA.*

# Number of starts before inhibition Start inhibit time delay



## Number of starts before inhibition

### Operation

The number of starts allowed before inhbition is calculated by the number of starts protection function (ANSI code 66).
The number of starts depends on the thermal state of the motor.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Resetting to zero

The number of starts counters may be reset to zero as follows, after the entry of a password:
- on the advanced UMI display unit by pressing the clear key
- on the display of a PC with the SFT2841 software
- the communication link (TC6).

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 60 |
| Unit | none |
| Display format | 3 significant digits |
| Resolution | 1 |
| Refresh interval | 1 second (typical) |

## Start inhibit time delay

### Operation

The start inhibit time only applies to the M40 and M41 motor applications. It depends on both the starts per hour protection (ANSI code 66) and the machine thermal overload protection (ANSI code 49 RMS) if they have been activated. This time expresses the waiting time until another start is allowed.

If at least one of these functions picks up, a "START INHIBIT" message informs the user that starting is not allowed.

### Readout

The number of starts and waiting time may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

### Characteristics

| | |
|---|---|
| Measurement range | 0 to 360 mn |
| Unit | mn |
| Display format | 3 significant digits |
| Resolution | 1 mn |
| Refresh interval | 1 second (typical) |

# Cumulative breaking current and number of operations

## Cumulative breaking current

### Operation

This function gives the cumulative breaking current in $(kA)^2$ for five current ranges.
It is based on measurement of the fundamental component.
The current ranges displayed are:

- 0 < I < 2 In
- 2 In < I < 5 In
- 5 In < I < 10 In
- 10 In < I < 40 In
- I > 40 In.

This function gives the cumulative breaking current in $(kA)^2$ for five current ranges.
Each value is saved in the event of an auxiliary power failure.
Refer to switchgear documentation for use of this information.

## Number of operations

The function also gives the total number of breaking device operations.
It is activated by tripping orders (O1 relay).
The number of operations is saved in the event of an auxiliary power failure.

### Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

The initial values may be introduced using the SFT2841 software tool to take into account the real state of a used breaking device.

### Characteristics

| **Cumulative breaking current $(kA)^2$** | |
|---|---|
| Range | 0 to 65535 $(kA)^2$ |
| Unit | primary $(kA)^2$ |
| Resolution | 1$(kA)^2$ |
| Accuracy (1) | ±10 % ±1 digit |
| **Number of operations** | |
| Range | 0 to 65535 |

***(1)*** *At In, in reference conditions (IEC 60255-6).*

# Operating time
# Charging time



## Operating time

### Operation

This function gives the value of the opening operating time of a breaking device **(1)** and change of status of the device open position contact connected to the I11 input **(2)**
The function is inhibited when the input is set for AC voltage **(3)**.
The value is saved in the event of an auxiliary power failure.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

***(1)*** *Refer to switchgear documentation for use of this information.*
***(2)*** *Optional MES module.*
***(3)*** *Optional MES114E or MES114F modules.*

### Characteristics

| | |
|---|---|
| Measurement range | 20 to 100 |
| Unit | ms |
| Accuracy | ±1 ms typical |
| Display format | 3 significant digits |
| Resolution | 1 ms |

## Charging time

### Operation

This function gives the value of the breaking device **(1)** operating mechanism charging time, determined according to the device closed position status change contact and the end of charging contact connected to the Sepam logic inputs **(2)**.
The value is saved in the event of an auxiliary power failure.

### Readout

The measurement may be accessed via:
- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

***(1)*** *Refer to switchgear documentation for use of this information.*
***(2)*** *Optional MES114 or MES114E or MES114F modules.*

### Characteristics

| | |
|---|---|
| Measurement range | 1 to 20 |
| Unit | s |
| Accuracy | ±0.5 sec |
| Display format | 3 significant digits |
| Resolution | 1s |

# VT supervision
ANSI code 60FL



## Operation

The VT (Voltage Transformer) supervision function is used to supervise the complete phase and residual voltage measurement chain:
- voltage transformers
- VT connection to Sepam
- Sepam voltage analog inputs.

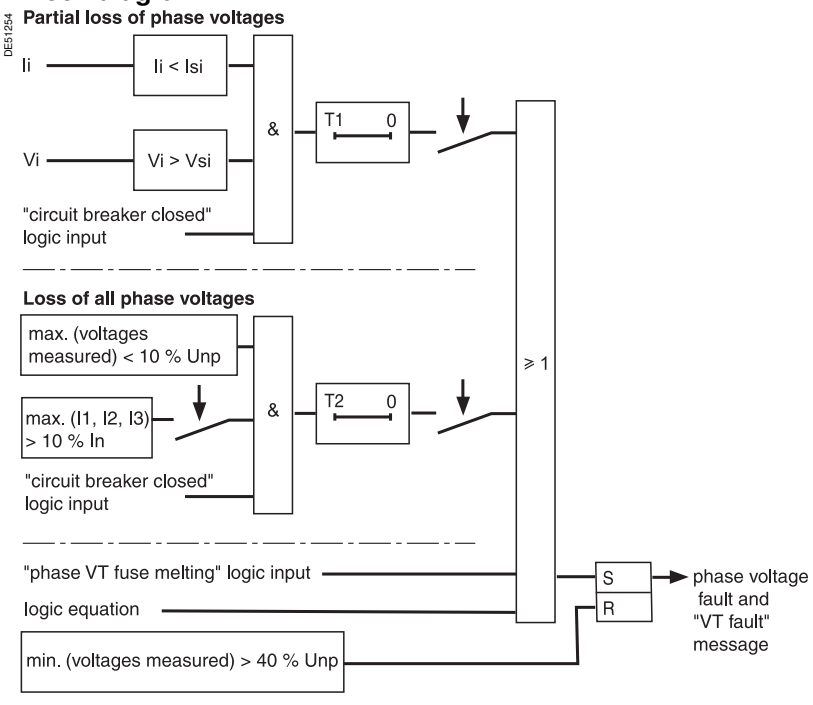
The function processes the following failures:
- partial loss of phase voltages, detected by:
  - presence of negative sequence voltage
  - and absence of negative sequence current
- loss of all phase voltages, detected by:
  - presence of current on one of the three phases
  - and absence of all measured voltages
- tripping of the phase VT (and/or residual VT) protection relay, detected by the acquisition on a logic input of the fuse melting contact or auxiliary contact of the circuit breaker protecting the VTs
- other types of failures may be processed using the logic equation editor.

The "Phase voltage fault" and "Residual voltage fault" information disappears automatically when the situation returns to normal, i.e. as soon as:
- the cause of the fault has disappeared
- and all of the measured voltages are present.

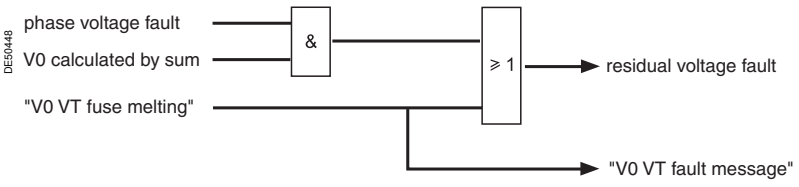
**Use of circuit breaker closed information**

The "circuit breaker closed" information is used to detect the loss of one, two or three voltages, if it is connected to a logic input.
If the "circuit breaker closed" information is not connected to a logic input, the detection of VT faults due to the loss of one, two or three voltages is not determined by the position of the circuit breaker.

## Block diagram




*Detection of phase voltage fault.*




*Detection of residual voltage fault.*

# VT supervision
ANSI code 60FL



## Consequences of a VT fault on protection functions

A "Phase voltage fault" affects the following protection functions:
- 27/27S, 27D, 32P, 32Q/40, 47, 51V
- 59, only in cases where the protection function is set up for phase-to-neutral overvoltage, when the voltages are measured by two phase VTs + V0 VT
- 67

A "residual voltage fault" affects the following protection functions:
- 59N
- 67N/67NC.

The behavior of the protection functions in the event of a "Phase voltage fault" or "Residual voltage fault" is to be set up and the following choices are proposed:
- for protection functions 27/27S, 27D, 32P, 32Q/40, 47, 51V, 59 and 59N: inhibition or no inhibition
- for protection function 67: inhibition or non-directional operation (50/51)
- for protection function 67N/67NC: inhibition or non-directional operation (50N/51N).

## Setting advice

The partial loss of voltages is based on the detection of the presence of negative sequence voltage and the absence of negative sequence current.
By default:
- the presence of negative sequence voltage is detected when: Vi > 10 % Vnp (Vsi)
- the absence of negative sequence current is detected when: Ii < 5 % In (Isi)
- time delay T1 is 1 s.

These default settings ensure the stability of the VT supervision function in the event of short-circuits or transient phenomena on the network.
The Isi set point may be raised for highly unbalanced networks.

Time delay T2 for the detection of the loss of all voltages must be longer than the time it takes for a short-circuit to be cleared by the protection function 50/51 or 67, to avoid the detection of a VT loss of voltage fault triggered by a 3-phase short-circuit.

The time delay for the 51V protection function must be longer than the T1 and T2 time delays used for the detection of voltage losses.

## Characteristics

| | |
|---|---|
| **Validation of the detection of partial loss of phase voltages** | |
| Setting | Yes / No |
| **Vsi set point** | |
| Setting | 2 % to 100 % of Vnp |
| Accuracy | ±2 % for Vi ≥ 10 % Vnp<br>±5 % for Vi < 10 % Vnp |
| Resolution | 1 % |
| Pick-up / drop-out ratio | (95 ±2.5) % for Vi ≥ 10 % Vnp |
| **Isi set point** | |
| Setting | 5 % to 100 % of In |
| Accuracy | ±5 % |
| Resolution | 1 % |
| Pick-up / drop-out ratio | (105 ±2.5) % |
| **Time delay T1 (partial loss of phase voltages)** | |
| Setting | 0.1 s to 300 s |
| Accuracy | ±2 % or ±25 ms |
| Resolution | 10 ms |
| **Validation of the detection of the loss of all phase voltages** | |
| Setting | Yes / No |
| **Detection of the loss of all voltages with verification of the presence of current** | |
| Setting | Yes / No |
| **Time delay T2 (loss of all voltages)** | |
| Setting | 0.1 s to 300 s |
| Accuracy | ±2 % or ±25 ms |
| Resolution | 10 ms |
| **Voltage and power protection behavior** | |
| Setting | No action / inhibition |
| **Protection 67 behavior** | |
| Setting | Non-directional / inhibition |
| **Protection 67N/67NC behavior** | |
| Setting | Non-directional / inhibition |

# CT supervision
ANSI code 60



## Operation

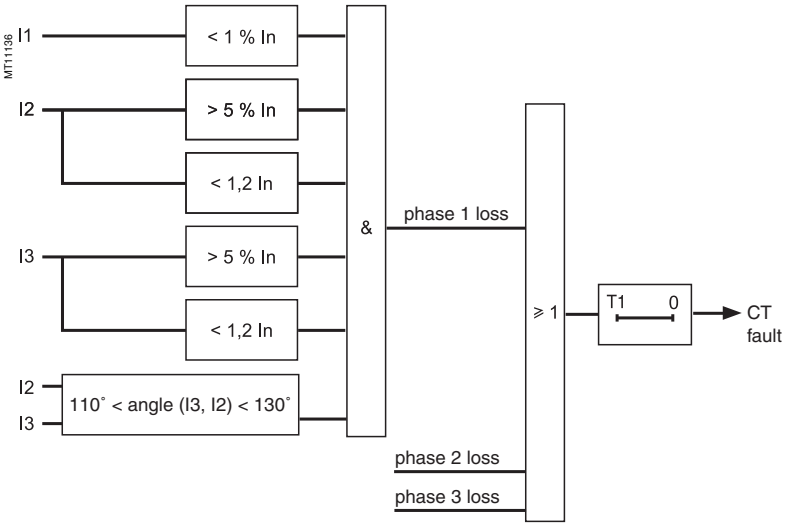
The CT (Current Transformer) supervision function is used to supervise the complete phase current measurement chain:
- phase current sensors (1 A/5 A CTs or LPCTs)
- phase current sensor connection to Sepam
- Sepam phase current analog inputs.

The function detects the loss of a phase current, when the three phase currents are measured.
The function is inactive if only 2 phase current sensors are connected.

The "CT fault" information disappears automatically when the situation returns to normal, i.e. as soon as the three phase currents are measured and have values greater than 10 % of In.

In the event of the loss of a phase current, the following protection functions may be inhibited to avoid nuisance tripping:
- 46, 46BC, 32P and 32Q/40
- 51N if I0 is calculated by the sum of the phase currents.

## Block diagram




## Characteristics

| | |
|---|---|
| **Time delay** | |
| Setting | 0.15 s to 300 s |
| Accuracy | ±2 % or ±25 ms |
| Resolution | 10 ms |
| **Inhibition of protection functions 46, 32P, 32Q/40, 51N** | |
| Setting | No action / inhibition |

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| Functions | Settings | | Time delays |
|---|---|---|---|
| **ANSI 27 - Phase-to-phase undervoltage** | | | |
| | 5 to 120 % of Unp | | 0.05 s to 300 s |
| **ANSI 27D/47 - Positive sequence undervoltage** | | | |
| | 5 to 60 % of Unp | | 0.05 s to 300 s |
| **ANSI 27R - Remanent undervoltage** | | | |
| | 5 to 100 % of Unp | | 0.05 s to 300 s |
| **ANSI 27S - Phase-to-neutral undervoltage** | | | |
| | 5 to 120 % of Vnp | | 0.05 s to 300 s |
| **ANSI 32P - Directional active overpower** | | | |
| | 1 to 120 % of Sn (1) | | 0.1 s to 300 s |
| **ANSI 32Q/40 - Directional reactive overpower** | | | |
| | 5 to 120 % of Sn (1) | | 0.1 s to 300 s |
| **ANSI 37 - Phase undercurrent** | | | |
| | 0.15 to 1 Ib | | 0.05 s to 300 s |
| **ANSI 38/49T - Temperature monitoring (8 or 16 RTDs)** | | | |
| Alarm and trip set points | 0 to 180 °C (or 32 to 356 °F) | | |
| **ANSI 46 - Negative sequence / unbalance** | | | |
| Definite time | 0.1 to 5 Ib | | 0.1 s to 300 s |
| IDMT | 0.1 to 0.5 Ib (Schneider Electric) 0.1 to 1 Ib (CEI, IEEE) | | 0.1 s to 1 s |
| Tripping curve | Schneider Electric | | |
| | CEI: SIT/A, LTI/B, VIT/B, EIT/C | | |
| | IEEE: MI (D), VI (E), EI (F) | | |
| **ANSI 46BC - Broken Conductor** | | | |
| Set point Ii/Id | 10 to 100 % | | 0.1 s to 300 s |
| **ANSI 47 - Negative sequence overvoltage** | | | |
| | 1 to 50 % of Unp | | 0.05 s to 300 s |
| **ANSI 48/51LR/14 - Excessive starting time, locked rotor** | | | |
| | 0.5 Ib to 5 Ib | ST starting time | 0.5 s to 300 s |
| | | LT and LTS time delays | 0.05 s to 300 s |
| **ANSI 49RMS - Thermal overload** | | **Rate 1** | **Rate 2** |
| Accounting for negative sequence component | | 0 - 2.25 - 4.5 - 9 | |
| Time constant | Heating | T1: 5 to 120 mn | T1: 5 to 120 mn |
| | Cooling | T2: 5 to 600 mn | T2: 5 to 600 mn |
| Alarm and tripping set points | | 50 to 300 % of rated thermal capacity | |
| Cold curve modification factor | | 0 to 100 % | |
| Switching of thermal settings conditions | | By logic input | |
| | | By Is set point adjustable from 0.25 to 8 Ib | |
| Maximum equipment temperature | | 60 to 200 °C | |

***(1)*** *Sn = $\sqrt{3}$ .In.Unp.*

| Functions | Settings | | Time delays |
|---|---|---|---|
| **ANSI 50/51 - Phase overcurrent** | | | |
| | **Tripping time delay** | **Timer hold** | |
| Tripping curve | Definite time | DT | |
| | SIT, LTI, VIT, EIT, UIT (1) | DT | |
| | RI | DT | |
| | CEI: SIT/A, LTI/B, VIT/B, EIT/C | DT or IDMT | |
| | IEEE: MI (D), VI (E), EI (F) | DT or IDMT | |
| | IAC: I, VI, EI | DT or IDMT | |
| Is set point | 0.1 to 24 In | Definite time | Inst ; 0.05 s to 300 s |
| | 0.1 to 2.4 In | IDMT | 0.1 s to 12.5 s at 10 Is |
| Timer hold | Definite time (DT ; timer hold) | | Inst ; 0.05 s to 300 s |
| | IDMT (IDMT ; reset time) | | 0.5 s to 20 s |
| Confirmation | None | | |
| | By negative sequence overvoltage | | |
| | By phase-to-phase undervoltage | | |
| Harmonic 2 restraint set point | 5 to 50% | | |
| Short circuit current Isc min | In to 999 kA | | |
| **CLPU 50/51 - Phase Overcurrent Cold Load Pick-Up/Blocking** | | | |
| Time before activation Tcold | | | 0.1 to 300 s |
| Pick-up threshold CLPUs | 10 to 100% of In | | |
| Global action CLPU 50/51 | Blocking or multiplication of the set point | | |
| Action on unit x ANSI 50/51 | OFF or ON | | |
| Time delay T/x | | | 100 ms to 999 min |
| Multiplying factor M/x | 100 to 999% of Is | | |
| **ANSI 50BF - Breaker failure** | | | |
| Presence of current | 0.2 to 2 In | | |
| Operating time | 0.05 s to 300 s | | |
| **ANSI 50N/51N or 50G/51G - Earth fault / Sensitive earth fault** | | | |
| | **Tripping time delay** | **Timer hold** | |
| Tripping curve | Definite time | DT | |
| | SIT, LTI, VIT, EIT, UIT (1) | DT | |
| | RI | DT | |
| | CEI: SIT/A,LTI/B, VIT/B, EIT/C | DT or IDMT | |
| | IEEE: MI (D), VI (E), EI (F) | DT or IDMT | |
| | IAC: I, VI, EI | DT or IDMT | |
| Is0 set point | 0.1 to 15 In0 | Definite time | Inst ; 0.05 s to 300 s |
| | 0.1 to 1 In0 | IDMT | 0.1 s to 12.5 s at 10 Is0 |
| Timer hold | Definite time (DT ; timer hold) | | Inst ; 0.05 s to 300 s |
| | IDMT (IDMT ; reset time) | | 0.5 s to 20 s |
| **CLPU 50N/51N - Earth Fault Cold Load Pick-Up/Blocking** | | | |
| Time before activation Tcold | | | 0.1 to 300 s |
| Pick-up threshold CLPUs | 10 to 100% of In0 | | |
| Global action CLPU 50N/51N | Blocking or multiplication of the set point | | |
| Action on unit x ANSI 50N/51N | OFF or ON | | |
| Time delay T0/x | | | 100 ms to 999 min |
| Multiplying factor M0/x | 100 to 999% of Is0 | | |
| **ANSI 50V/51V - Voltage-restrained overcurrent** | | | |
| | **Tripping time delay** | **Timer hold** | |
| Tripping curve | Definite time | DT | |
| | SIT, LTI, VIT, EIT, UIT (1) | DT | |
| | RI | DT | |
| | CEI: SIT/A, LTI/B, VIT/B, EIT/C | DT or IDMT | |
| | IEEE: MI (D), VI (E), EI (F) | DT or IDMT | |
| | IAC: I, VI, EI | DT or IDMT | |
| Is set point | 0.5 to 24 In | Definite time | Inst ; 0.05 s to 300 s |
| | 0.5 to 2,4 In | IDMT | 0.1 s to 12.5 s at 10 Is |
| Timer hold | Definite time (DT ; timer hold) | | Inst ; 0.05 s to 300 s |
| | IDMT (IDMT ; reset time) | | 0.5 s to 20 s |

***(1)*** *Tripping as of 1.2 Is.*

| Functions | Settings | | Time delays |
|---|---|---|---|
| **ANSI 59 - Overvoltage (L-L or L-N)** | | | |
| | 50 to 150% of Unp (or Vnp) if Uns < 208 V | | 0.05 to 300 s |
| | 50 to 135% of Unp (or Vnp) if Uns ⩾ 208 V | | 0.05 to 300 s |
| **ANSI 59N - Neutral voltage displacement** | | | |
| | 2 to 80 % of Unp | | 0.05 s to 300 s |
| **ANSI 66 - Starts per hour** | | | |
| Starts per period | 1 to 60 | Period | 1 to 6 hr |
| Consecutive starts | 1 to 60 | Time between starts | 0 to 90 mn |
| **ANSI 67 - Directional phase overcurrent** | | | |
| | **Tripping time delay** | **Timer hold** | |
| Tripping curve | Definite time | DT | |
| | SIT, LTI, VIT, EIT, UIT (1) | DT | |
| | RI | DT | |
| | CEI: SIT/A, LTI/B, VIT/B, EIT/C | DT or IDMT | |
| | IEEE: MI (D), VI (E), EI (F) | DT or IDMT | |
| | IAC: I, VI, EI | DT or IDMT | |
| Is set point | 0.1 to 24 In | Definite time | Inst ; 0.05 s to 300 s |
| | 0.1 to 2,4 In | IDMT | 0.1 s to 12.5 s at 10 Is |
| Timer hold | Definite time (DT ; timer hold) | | Inst ; 0.05 s to 300 s |
| | IDMT (IDMT ; reset time) | | 0.5 s to 20 s |
| Characteristic angle | 30°, 45°, 60° | | |
| **ANSI 67N/67NC type 1 - Directional earth fault, according to I0 projection** | | | |
| Characteristic angle | -45°, 0°, 15°, 30°, 45°, 60°, 90° | | |
| Is0 set point | 0.1 to 15 In0 | Definite time | Inst ; 0.05 s to 300 s |
| Vs0 set point | 2 to 80 % of Un | | |
| Memory time | T0mem time | 0 ; 0.05 s to 300 s | |
| | V0mem validity set point | 0 ; 2 to 80 % of Unp | |
| **ANSI 67N/67NC type 2 - Directional earth fault, according to I0 magnitude with half-plan tripping zone** | | | |
| Characteristic angle | -45°, 0°, 15°, 30°, 45°, 60°, 90° | | |
| | **Tripping time delay** | **Timer hold** | |
| Tripping curve | Definite time | DT | |
| | SIT, LTI, VIT, EIT, UIT (1) | DT | |
| | RI | DT | |
| | CEI: SIT/A,LTI/B, VIT/B, EIT/C | DT or IDMT | |
| | IEEE: MI (D), VI (E), EI (F) | DT or IDMT | |
| | IAC: I, VI, EI | DT or IDMT | |
| Is0 set point | 0.1 to 15 In0 | Definite time | Inst ; 0.05 s to 300 s |
| | 0.1 to 1 In0 | IDMT | 0.1 s to 12.5 s at 10 Is0 |
| Vs0 set point | 2 to 80 % of Unp | | |
| Timer hold | Definite time (DT ; timer hold) | | Inst ; 0.05 s to 300 s |
| | IDMT (IDMT ; reset time) | | 0.5 s to 20 s |
| **ANSI 67N/67NC type 3 - Directional earth fault, according to I0 magnitude with angular sector tripping zone** | | | |
| Angle at start of tripping zone | 0° to 359° | | |
| Angle at end of tripping zone | 0° to 359° | | |
| Is0 set point CSH core balance CT | 2 A rating: 0.1 A to 30 A | Definite time | Inst ; 0.05 to 300 s |
| | 20 A rating: 2 A to 300 A | Definite time | Inst ; 0.05 to 300 s |
| 1 A CT (sensitive, In0 = 0.1 CT In) | 0.05 to 15 In0 (min. 0.1 A) | | |
| Core balance CT + ACE990 (range 1) | 0.05 to 15 In0 (min. 0.1 A) | | |
| Vs0 set point | Calculated V0 (sum of 3 voltages) | 2 to 80 % of Unp | |
| | Measured V0 (external VT) | 0.6 to 80 % of Unp | |
| **ANSI 81H - Overfrequency** | | | |
| | 50 to 55 Hz or 60 to 65 Hz | | 0.1 s to 300 s |
| **ANSI 81L - Underfrequency** | | | |
| | 40 to 50 Hz or 50 to 60 Hz | | 0.1 s to 300 s |

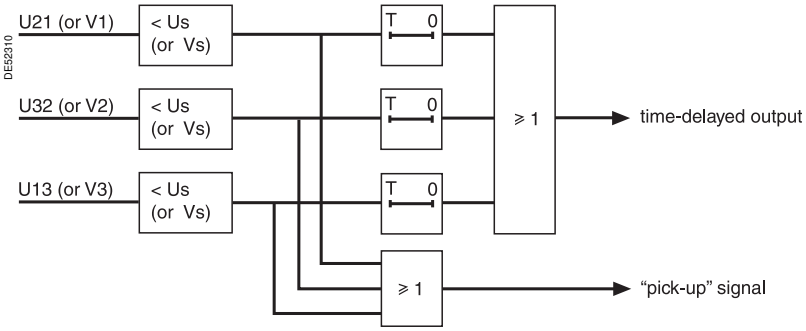
***(1)*** *Tripping as of 1.2 Is.*

# Undervoltage
ANSI code 27/27S

## Operation

The protection function is three-phase and operates according to parameter setting with phase-to-neutral or phase-to-phase voltage:
- it picks up if one of the 3 phase-to-neutral or phase-to-phase voltages drops below the Us (or Vs) set point
- it includes a definite time delay T
- with phase-to-neutral operation, it indicates the faulty phase in the alarm associated with the fault.

## Block diagram




## Characteristics

| | |
|---|---|
| **Us (or Vs) set point** | |
| Setting | 5 % Unp (or Vnp) to 120 % Unp (or Vnp) |
| Accuracy (1) | ±2 % or ±0.002 Unp |
| Resolution | 1 % |
| Drop out/pick up ratio | 103 % ±2.5 % |
| **Time delay T** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | pick-up < 35 ms (typically 25 ms) |
| Overshoot time | < 35 ms |
| Reset time | < 40 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

| **Connection conditions** | | | | | |
|---|---|---|---|---|---|
| Type of connection | V1, V2, V3 | U21 | U21, U32 | U21 + V0 | U21, U32 + V0 |
| Phase-to-neutral operation | Yes | No | No | No | Yes |
| Phase-to-phase operation | Yes | on U21 only | Yes | on U21 only | Yes |

# Positive sequence undervoltage and phase rotation direction check
ANSI code 27D/47

## Operation

**Positive sequence undervoltage**
The protection picks up when the positive sequence component Vd of a three-phase voltage system drops below the Vsd set point with:

$$\vec{V}d = (1/3)[\vec{V}1 + a\vec{V}2 + a^2\vec{V}3]$$

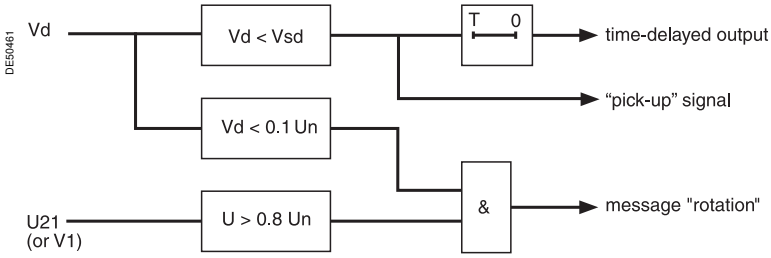
$$\vec{V}d = (1/3)[\vec{U}21 - a^2\vec{U}32]$$

with $V = \frac{U}{\sqrt{3}}$ and $a = e^{j\frac{2\pi}{3}}$

- it includes a definite time delay T
- it allows drops in motor electrical torque to be detected.

**Phase rotation direction**
This protection also allows the phase rotation direction to be detected.
The protection considers that the phase rotation direction is inverse when the positive sequence voltage is less than 10 % of Unp and when the phase-to-phase voltage is greater than 80 % of Unp.

## Block diagram




## Characteristics

| | |
|---|---|
| **Vsd set point** | |
| Setting | 5 % Unp to 60 % Unp |
| Accuracy (1) | ±2 % |
| Pick-up/drop-out ratio | 103 % ±2.5 % |
| Resolution | 1 % |
| **Time delay** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or from -25 ms to +35 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operating time | pick up < 55 ms |
| Overshoot time | < 35 ms |
| Reset time | < 35 ms |

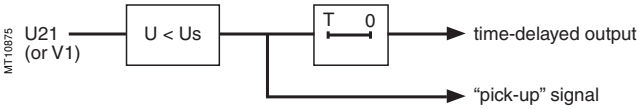
***(1)*** *In reference conditions (IEC 60255-6).*

# Remanent undervoltage
ANSI code 27R

## Operation

This protection is single-phase:
- it picks up when the U21 phase-to-phase voltage is less than the Us set point
- the protection includes a definite time delay.

## Block diagram

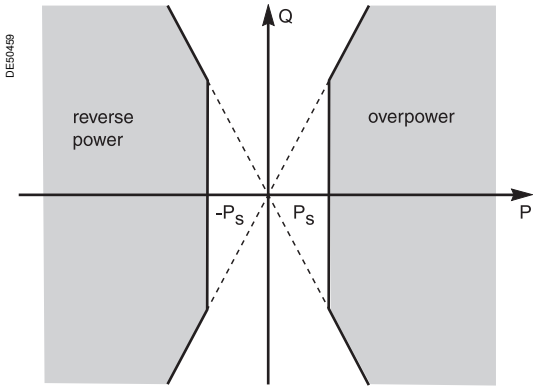



## Characteristics

| | |
|---|---|
| **Us set point** | |
| Setting | 5 % Unp to 100 % Unp |
| Accuracy (1) | ±5 % or ±0.005 Unp |
| Resolution | 1 % |
| Drop out/pick up ratio | 104 % ±3 % |
| **Time delay T** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | < 40 ms |
| Overshoot time | < 20 ms |
| Reset time | < 30 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

# Directional active overpower
ANSI code 32P




*Operating zone.*

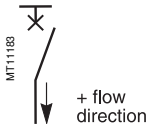


## Operation

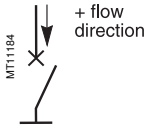
This function may be used as:
- "active overpower" protection for energy management (load shedding) or
- "reverse active power" protection against motors running like generators and generators running like motors.

It picks up if the active power flowing in one direction or the other (supplied or absorbed) is greater than the Ps set point.
It includes a definite time delay T.
It is based on the two-wattmeter method.
The function is only enabled if the following condition is met:
P ⩾ 3.1 % Q which provides a high level of sensitivity and high stability in the event of short-circuits.

The power sign is determined according to the general feeder or incomer parameter, iaccording to the convention:
- for the feeder circuit:
  - power exported by the busbar is positive
  - power supplied to the busbar is negative.

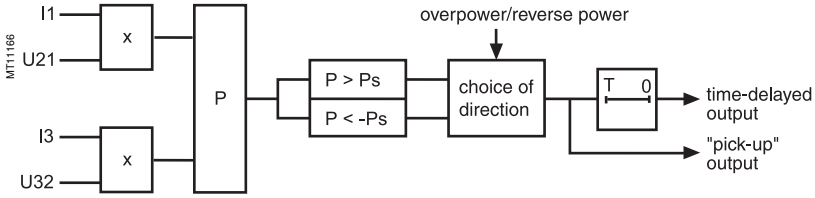



- for the incomer circuit:
  - power supplied to the busbar is positive
  - power exported by the busbar is negative




This protection function operates for V1V2V3, U21/U32 and U21/U32 + V0 connections.

## Block diagram

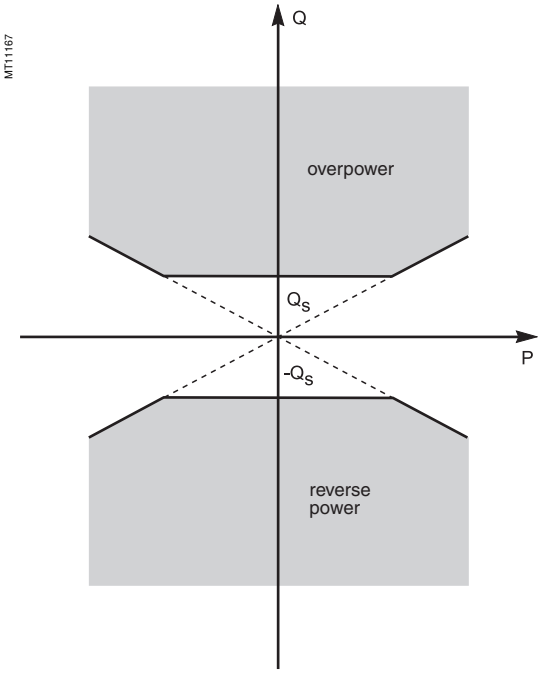



## Characteristics

| | |
|---|---|
| **Tripping direction** | |
| Setting | overpower/reverse power |
| **Ps set point** | |
| Setting | 1 % Sn (1) to 120 % Sn (1) |
| Resolution | 0.1 kW |
| Accuracy (2) | ±0.3 % Sn for Ps between 1 % Sn and 5 % Sn |
| | ±5 % for Ps between 5 % Sn and 40 % Sn |
| | ±3 % for Ps between 40 % Sn and 120 % Sn |
| Drop out/pick up ratio | (93.5 ±5) % |
| Min. return variance | 0.004 Sn |
| **Time delay T** | |
| Setting | 100 ms to 300 s |
| Resolution | 10 ms or 1 digit |
| Accuracy (2) | ±2 %, or from -10 ms to +35 ms |
| **Characteristic times** | |
| Operation time | < 80 ms |
| Overshoot time | < 90 ms |
| Reset time | < 80 ms |

***(1)*** *Sn = $\sqrt{3}$.Unp.In.*
***(2)*** *In reference conditions (IEC 60255-6).*

# Directional reactive overpower
ANSI code 32Q/40



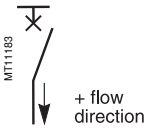

*Operating zone.*

## Operation

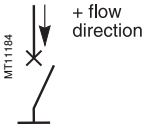
This protection function is used to detect field loss on synchronous machines (generators or motors) connected to the network.
In both cases, the machine undergoes additional temperature build-up which may damage it.
It picks up if the reactive power flowing in one direction or the other (supplied or absorbed) is greater than the Qs set point.
It includes a definite time delay T.
It is based on the two-wattmeter method.
The function is only enabled if the following condition is met:
Q ⩾ 3.1 % P which provides a high level of sensitivity and high stability in the event of short-circuits.

The power sign is determined according to the general feeder or incomer parameter, iaccording to the convention:

■ for the feeder circuit:
□ power exported by the busbar is positive
□ power supplied to the busbar is negative

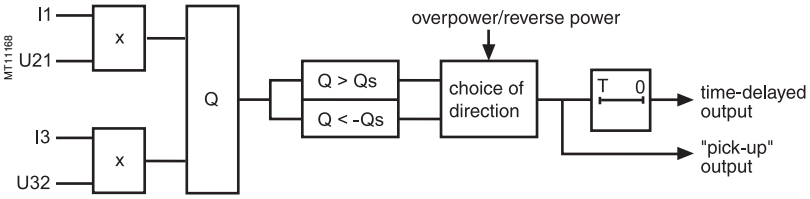



■ for the incomer circuit:
□ power supplied to the busbar is positive
□ power exported by the busbar is negative.




This protection function operates for V1V2V3, U21/U32 and U21/U32 + V0 connections.
To operate with certain synchronous motors, it may be necessary to inhibit the protection function during motor starting. This is done using the "Starting in progress" output of the 48/51LR function in the equation editor.

## Block diagram




## Characteristics

| | |
|---|---|
| **Tripping direction** | |
| Setting | overpower/reverse power |
| **Qs set point** | |
| Setting | 5 % Sn (1) to 120 % Sn (1) |
| Resolution | 0.1 var |
| Accuracy (2) | ±5 % for Qs between 5 % Sn and 40 % Sn |
| | ±3 % for Qs between 40 % Sn and 120 % Sn |
| Drop out/pick up ratio | (93.5 ±5) % |
| **Time delay T** | |
| Setting | 100 ms to 300 s |
| Resolution | 10 ms or 1 digit |
| Accuracy (2) | ±2 %, or from -10 ms to +35 ms |
| **Characteristic times** | |
| Operation time | < 80 ms |
| Overshoot time | < 90 ms |
| Reset time | < 80 ms |

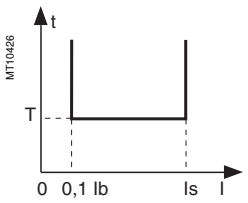
***(1)*** *Sn = $\sqrt{3}$.Unp.In.*
***(2)*** *In reference conditions (IEC 60255-6).*

# Phase undercurrent
ANSI code 37

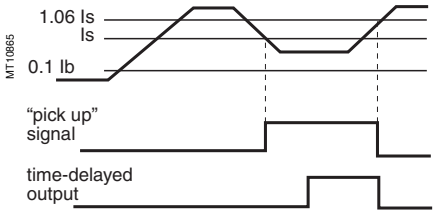
## Operation

This protection is single-phase:
- it picks up when phase 1 current drops below the Is set point
- it is inactive when the current is less than 10 % of Ib
- it is insensitive to current drops (breaking) due to circuit breaker tripping
- it includes a definite time delay T.

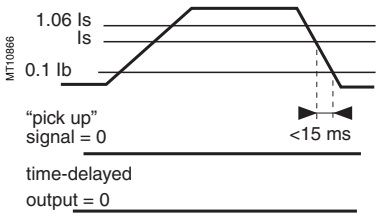
Tripping of the undercurrent protection may be inhibited by the logic input "Inhibit undercurrent".




### Operating principle

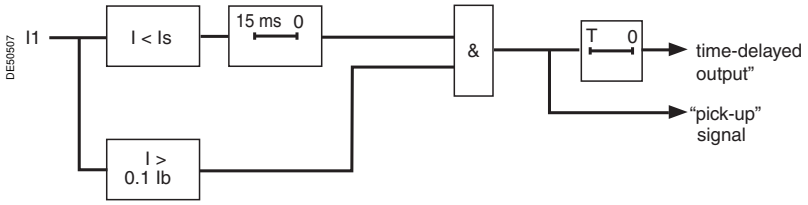



*Case of current sag.*




*Case of circuit breaker tripping.*

## Block diagram




## Characteristics

| | |
|---|---|
| **Is set point** | |
| Setting | 15 % Ib ⩽ Is ⩽ 100 % Ib by steps of 1 % |
| Accuracy (1) | ±5 % |
| Pick-up/drop-out ratio | 106 % ±5 % for Is > 0.1 In |
| **T time delay** | |
| Setting | 50 ms ⩽ T ⩽ 300 s |
| Accuracy (1) | ±2 % or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | < 60 ms |
| Overshoot time | < 35 ms |
| Reset time | < 40 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

# Temperature monitoring
ANSI code 38/49T

## Operation

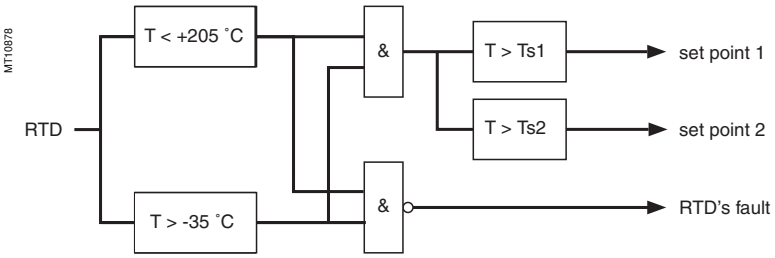
This protection is associated with an RTD of the Pt100 platinum (100 Ω at 0 °C or 32 °F) or Ni 100 or Ni 120 nickel type in accordance with the IEC 60751 and DIN 43760 standards.

- it picks up when the monitored temperature is greater than the Ts set point
- it has two independent set points:
  - alarm set point
  - tripping set point
- when the protection is activated, it detects whether the RTD is shorted or disconnected:
  - RTD shorting is detected if the measured temperature is less than -35 °C or -31 °F (measurement displayed "****")
  - RTD disconnection is detected if the measured temperature is greater than +205 °C or +482 °F (measurement displayed "-****").

If an RTD fault is detected, the set point output relays are inhibited: the protection outputs are set to zero.
The "RTD fault" item is also made available in the control matrix and an alarm message is generated specifying the faulty RTD module.



## Block diagram




## Characteristics

| Ts1 and Ts2 set points | °C | °F |
|---|---|---|
| Setting | 0 °C to 180 °C | 32 °F to 356 °F |
| Accuracy (1) | ±1,5 °C | ±2.7 °F |
| Resolution | 1 °C | 1 °F |
| Pick-up/drop-out difference | 3 °C ±0,5 ° | |
| **Characteristic times** | | |
| Tripping time | < 5 seconds | |

*(1) See **"connection of MET148-2 module"** chapter for accuracy derating according to wiring cross-section.*

## Standard RTD assignments

The standard assignments described below may be selected when the first MET148□2 module is configured (SFT2841 hardware configuration screen). It is compulsory to choose an assignment in order to use the thermal overload "Cooling time constant calculation" function.

| | Motor/generator choice (M40, M41, G40) | Transformer choice (T40, T50, T42, T52) |
|---|---|---|
| RTD 1 | Stator 1 | Phase 1-T1 |
| RTD 2 | Stator 2 | Phase 1-T2 |
| RTD 3 | Stator 3 | Phase 2-T1 |
| RTD 4 | Bearing 1 | Phase 2-T2 |
| RTD 5 | Bearing 2 | Phase 3-T1 |
| RTD 6 | Bearing 3 | Phase 3-T2 |
| RTD 7 | Bearing 4 | |
| RTD 8 | Ambient temperature | Ambient temperature |

# Negative sequence / unbalance
ANSI code 46



## Operation

The negative sequence / unbalance protection function:
- picks up if the negative sequence component of phase currents is greater than the operation set point
- it is time-delayed. The time delay may be definite time or IDMT according to a standardized curve or specially adapted Schneider curve.

The negative sequence current is determined according to the 3 phase currents.

$$\vec{Ii} = \frac{1}{3} \times (\vec{I1} + a^2 \vec{I2} + a \vec{I3})$$

with $a = e^{j\frac{2\pi}{3}}$

If Sepam is connected to 2 phase current sensors only, the negative sequence current is:

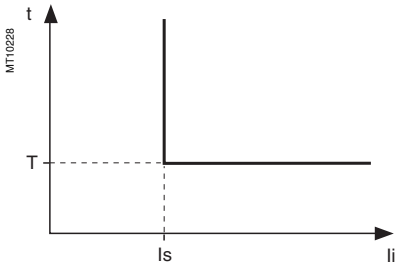
$$\left|\vec{Ii}\right| = \frac{1}{\sqrt{3}} \times \left|\vec{I1} - a^2 \vec{I3}\right|$$

with $a = e^{j\frac{2\pi}{3}}$

Both formulas are equivalent when there is no zero sequence current (earth fault).

**Definite time protection**

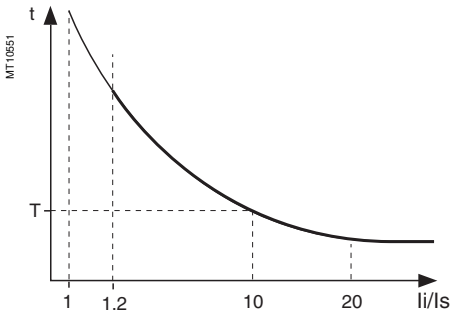
Is is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

**Standardized IDMT protection**

IDMT protection operates in accordance with the IEC 60255-3, BS 142 and IEEE C-37112 standards.




*IDMT protection principle.*

The Is setting is the vertical asymptote of the curve and T is the operation time delay for 10 Is.

For currents with a very large amplitude, the protection function has a definite time characteristic:
- if Ii > 20 Is, tripping time is the time that corresponds to 20 Is
- if Ii > 40 In, tripping time is the time that corresponds to 40 In.

The following standardized tripping curves are proposed:
- IEC standard inverse time SIT / A
- IEC very inverse time VIT or LTI / B
- IEC extremely inverse time EIT / C
- IEEE moderately inverse (IEC / D)
- IEEE very inverse (IEC / E)
- IEEE extremely inverse (IEC / F)

The curve equations are given in the chapter entitled "IDMT protection functions".

**IDMT protection Schneider curve**

For Ii > Is, the time delay depends on the value of Ii/Ib (Ib: basis current of the protected equipment defined when the general parameters are set).

T corresponds to the time delay for Ii/Ib = 5

The tripping curve is defined according to the following equations:
- for Is/Ib ⩽ Ii/Ib ⩽ 0.5

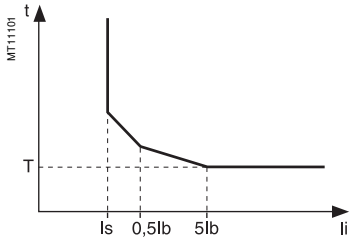
$$t = \frac{3.19}{(Ii/Ib)^{1.5}} \cdot T$$

- for 0.5 ⩽ Ii/Ib ⩽ 5

$$t = \frac{4.64}{(Ii/Ib)^{0.96}} \cdot T$$

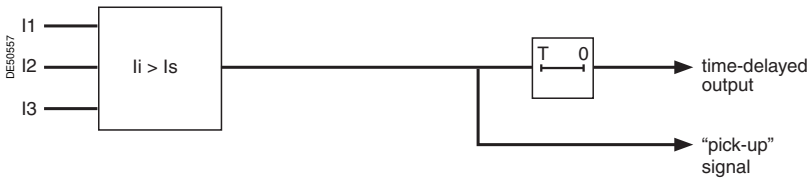
- for Ii/Ib > 5

$t = T$




*Schneider curve.*

## Block diagram




## Characteristics

| | | |
|---|---|---|
| **Curve** | | |
| Setting | Definite, standardized IDMT (a choice of 6), Schneider IDMT | |
| **Is set point** | | |
| Setting | Definite time | 10 % Ib ⩽ Is ⩽ 500 % Ib |
| | Standardized IDMT (IEC, IEEE) | 10 % Ib ⩽ Is ⩽ 100 % Ib |
| | Schneider IDMT | 10 % Ib ⩽ Is ⩽ 50 % Ib |
| Resolution | | 1 % |
| Accuracy (1) | | ±5 % |
| **Time delay T** | | |
| Setting | Definite time | 100 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 1 s |
| Resolution | | 10 ms or 1 digit |
| Accuracy (1) | Definite time | ±2 % or ±25 ms |
| | IDMT | ±5 % or ±35 ms |
| **Characteristic times** | | |
| Operation time | | pick-up < 55 ms |
| Overshoot time | | < 35 ms |
| Reset time | | < 55 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

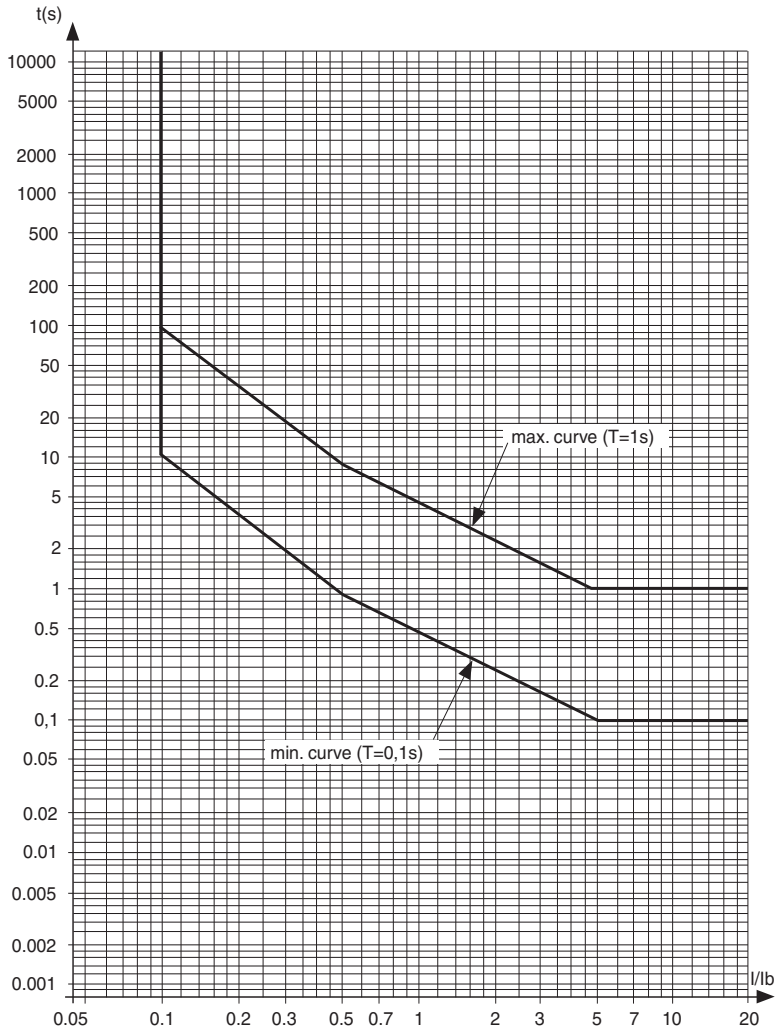
### Determination of tripping time for different negative sequence current values for a given Schneider curve

Use the table to find the value of K that corresponds to the required negative sequence current.
The tripping time is equal to KT.

**Example**

given a tripping curve with the setting T = 0.5 s.
What is the tripping time at 0.6 Ib?
Use the table to find the value of K that corresponds to 60 % of Ib.
The table reads K = 7.55. The tripping time is equal to:
0.5 x 7.55 = 3.755 s.

**IDMT tripping Schneider curve**




| **Ii (% Ib)** | 10 | 15 | 20 | 25 | 30 | 33.33 | 35 | 40 | 45 | 50 | 55 | 57.7 | 60 | 65 | 70 | 75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **K** | 99.95 | 54.50 | 35.44 | 25.38 | 19.32 | 16.51 | 15.34 | 12.56 | 10.53 | 9.00 | 8.21 | 7.84 | 7.55 | 7.00 | 6.52 | 6.11 |

| **Ii (% Ib)** cont'd | 80 | 85 | 90 | 95 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **K** cont'd | 5.74 | 5.42 | 5.13 | 4.87 | 4.64 | 4.24 | 3.90 | 3.61 | 3.37 | 3.15 | 2.96 | 2.80 | 2.65 | 2.52 | 2.40 | 2.29 |

| **Ii (% Ib)** cont'd | 22. | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 | 310 | 320 | 330 | 340 | 350 | 360 | 370 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **K** cont'd | 2.14 | 2.10 | 2.01 | 1.94 | 1.86 | 1.80 | 1.74 | 1.68 | 1.627 | 1.577 | 1.53 | 1.485 | 1.444 | 1.404 | 1.367 | 1.332 |

| **Ii (% Ib)** cont'd | 380 | 390 | 400 | 410 | 420 | 430 | 440 | 450 | 460 | 470 | 480 | 490 | ⩾ 500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **K** cont'd | 1.298 | 1.267 | 1.236 | 1.18 | 1.167 | 1.154 | 1.13 | 1.105 | 1.082 | 1.06 | 1.04 | 1.02 | 1 |

# Broken conductor
ANSI code 46BC

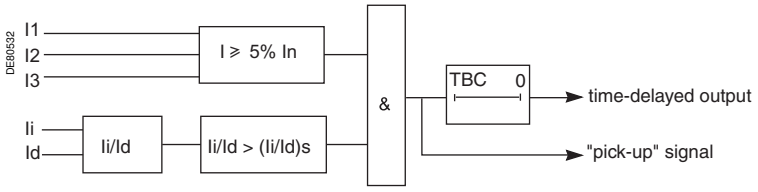
## Description
The purpose of Broken conductor detection protection is to indicate, on a radial medium-voltage network, the opening of a phase at a point on the circuit.
This may have several origins:
- broken conductor on the ground at the source end
- broken conductor on the ground at the load end
- open wire without conductor on the ground due to:
  - a broken conductor
  - a blown fuse
  - a problem with a circuit breaker phase.



## Operation
Broken conductor detection protection is based on the negative sequence and positive sequence current ratio, which makes it independent of the load fluctuations on the network.
However, these performances depend on:
- the installation:
  - the transformer neutral earthing system
  - capacitive current
  - presence of a permanent negative sequence
- the nature of the fault:
  - broken conductor with either 1 end on the ground at the source end, or 1 end on the ground at the load end, or no end touching the ground
  - distance between the protection relay and the location of the break
  - fault impedance. The impedance depends mainly on the nature of the ground where the fault occurred.

This protection function needs to be wired to 3 phase CTs in working order. If the wiring is with 2 phase CTs or if the CT supervision function has detected a problem, the protection function is automatically inhibited.

By default, the protection is off.

## Block diagram



## Protection setting assistance
**Setting the set point (Ii/Id)s**
The further away or more impedant the fault to be detected is, the more sensitive the protection setting needs to be, that is to say the lower the set point (Ii/Id)s setting should be.
However, there may be a permanent negative sequence on the network due to the loads connected. In this case, the protection set point must be set higher than this negative sequence.
To set the protection set point, you must:
- read the peak demand negative sequence and positive sequence current ratio value (see page 32) after a time representative of the activity on the installation
- set the set point (Ii/Id)s to a value 30 to 50% higher than the value read on the peak demand meter.

**Setting the TBC time delay**
A significant negative sequence may appear briefly on the network, for example after a transformer switches downstream, or after a short-circuit. For this reason, it is advisable to choose a TBC time delay of at least 1 second, and in any case longer than that for the other protection functions.

## Characteristics
| | | |
|---|---|---|
| **Set point (Ii/Id)s** | | |
| Setting | | 10 to 100% |
| Resolution | | 1% |
| **TBC time delay** | | |
| Setting | definite time | 0.1 to 300 s |
| Accuracy (1) | | ±2%, or ±25 ms |
| Resolution | | 10 ms or 1 digit |

***(1)*** *Under reference conditions (IEC 60255-6).*

# Negative sequence overvoltage
ANSI code 47

## Operation

The protection function picks up if the negative sequence component of the voltages (Vi) is above the set point (Vsi).

- it includes a definite time delay T
- the negative sequence voltage Vi is determined from the three phase voltages:

$$\vec{Vi} = \frac{1}{3}(\vec{V1} + a^2\vec{V2} + a\vec{V3})$$

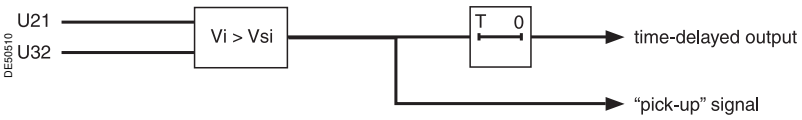
or

$$\vec{Vi} = \frac{1}{3}(\vec{U21} - a\vec{U32})$$

with $a = e^{j\frac{2\pi}{3}}$

This protection function only operates with connections V1V2V3, U21/U32 + V0 and U21/U32.

## Block diagram

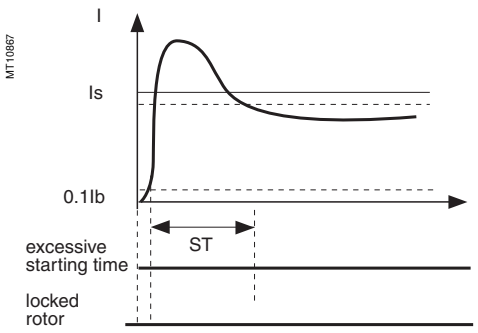



## Characteristics

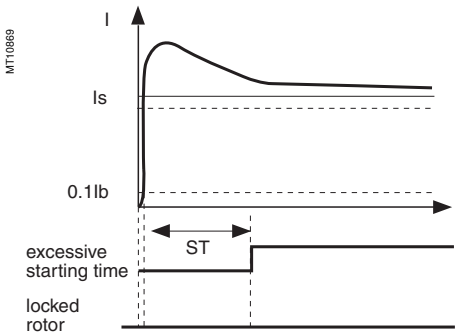
| | |
|---|---|
| **Vsi set point** | |
| Setting | 1 % Unp to 50 % Unp |
| Accuracy (1) | ±2 % for Vi ≥ 10 % Unp |
| | ±5 % for Vi < 10 % Unp |
| Resolution | 1 % |
| Drop out/pick up ratio | (97 ±2.5) % at Vi ≥ 10 % Unp |
| **Time delay T** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | pick-up < 55 ms |
| Overshoot time | < 35 ms |
| Reset time | < 55 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

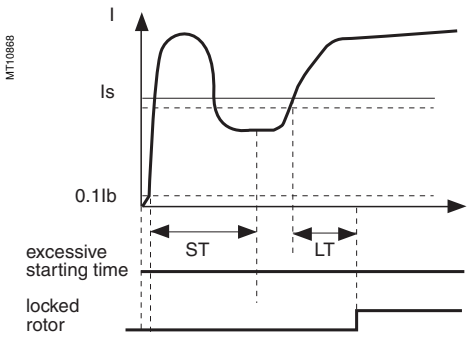
# Excessive starting time, locked rotor
## ANSI code 48/51LR/14



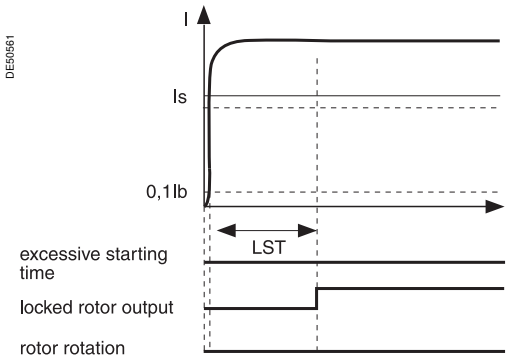

*Case of normal starting.*




*Case of excessive starting time.*




*Case of locked rotor.*




*Case of starting locked rotor.*

### Operation

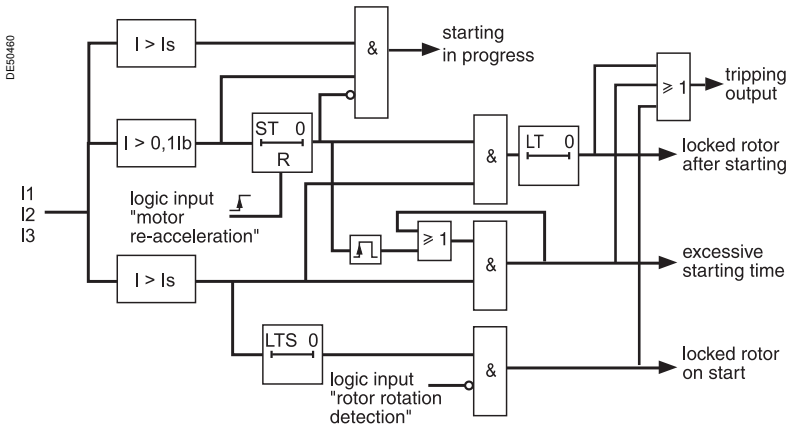
This function is three-phase.
It comprises two parts:
- excessive starting time: during starting, the protection picks up when one of the 3 phase currents is greater than the set point Is for a longer period of time than the ST time delay (normal starting time)
- locked rotor:
  - at the normal operating rate (after starting), the protection picks up when one of the 3 phase currents is greater than the set point Is for a longer period of time than the LT time delay of the definite time type.
  - locked on start: large motors may have very long starting time, due to their inertia or the reduce voltage supply. This starting time is longer than the permissive rotor blocking time. To protect such a motor LTS timer initiate a trip if a start has been detected (I > Is) or if the motor speed is zero. For a normal start, the input I23 (zero-speed-switch) disable this protection.

**Motor re-acceleration**

When the motor re-accelerates, it consumes a current in the vicinity of the starting current (> Is) without the current first passing through a value less than 10 % of Ib. The ST time delay, which corresponds to the normal starting time, may be reinitialized by the logic input "motor re-acceleration" which:
- reinitialize the **excessive starting time** protection,
- set the **locked rotor** protection LT time delay to a low value.

Starting is detected when the current consumed is 10 % greater than the Ib current. An output is set when starting is in progress, to be used in the equation editor.

### Block diagram




### Characteristics

| | | |
|---|---|---|
| **Is set point** | | |
| Setting | | 50 % Ib ⩽ Is ⩽ 500 % Ib |
| Resolution | | 1 % |
| Accuracy (1) | | ±5 % |
| Drop out/pick up ratio | | 93.5 % ±5 % |
| **Time delay ST, LT and LTS** | | |
| Setting | ST | 500 ms ⩽ T ⩽ 300 s |
| | LT | 50 ms ⩽ T ⩽ 300 s |
| | LTS | 50 ms ⩽ T ⩽ 300 s |
| Resolution | | 10 ms or 1 digit |
| Accuracy (1) | | ±2 % or from -25 ms to +40 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

# Thermal overload
## ANSI code 49 RMS

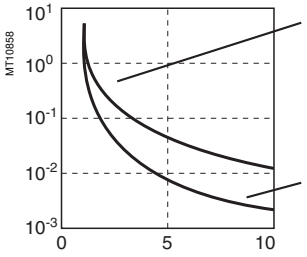
### Description

This function is used to protect equipment (motors, transformers, generators, lines, capacitors) against overloads, based on measurement of the current consumed.

**Operation curve**

The protection gives a trip order when the heat rise E, calculated according to the measurement of an equivalent current Ieq, is greater than the set point Es.
The greatest permissible continuous current is
$I = Ib\sqrt{Es}$
The protection tripping time is set by the time constant T.

- the calculated heat rise depends on the current consumed and the previous heat rise state
- the cold curve defines the protection tripping time based on zero heat rise
- the hot curve defines the protection tripping time based on 100 % nominal heat rise.




$$\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$$

$$\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2 - 1}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$$

**Alarm set point, tripping set point**

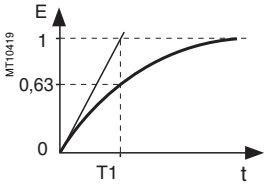
Two set points may be set for heat rise:

- Es1: alarm.
- Es2: tripping.

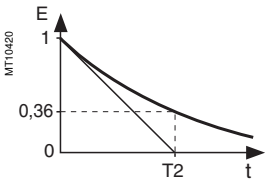
**"Hot state" set point**

When the function is used to protect a motor, this fixed set point is designed for detection of the hot state used by the number of starts function.
The value of the fixed set point is 50 %.

**Heat rise and cooling time constants**




*Heat rise time constant.*




*Cooling time constant.*

For self-ventilated rotating machines, cooling is more effective when the machine is running than when it is stopped. Running and stopping of the equipment are calculated from the value of the current:

- running if I > 0.1 Ib
- stopped if I < 0.1 Ib.

Two time constants may be set:

- T1: heat rise time constant: concerns equipment that is running
- T2: cooling time constant: concerns equipment that is stopped.

**Accounting for harmonics**

The current measured by the thermal protection is an RMS 3-phase current which takes into account harmonics up to number 17.

**Accounting for ambient temperature**

Most machines are designed to operate at a maximum ambient temperature of 40 °C (104 °F). The thermal overload function takes into account the ambient temperature (Sepam equipped with the temperature sensor module option, with sensor no. 8 assigned to measurement of ambient temperature) to increase the calculated heat rise value when the temperature measured exceeds 40 °C (104 °F).

Increase factor: $fa = \frac{Tmax - 40°C}{Tmax - Tambient}$

in whichT max is the equipment's maximum temperature
(according to insulation class).
T ambient is the measured temperature.

**Adaptation of the protection to motor thermal withstand**

Motor thermal protection is often set based on the hot and cold curves supplied by the machine manufacturer. To fully comply with these experimental curves, additional parameters must be set:

- initial heat rise, Es0, is used to reduce the cold tripping time.

modified cold curve: $\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2 - Es0}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$

- a second group of parameters (time constants and set points) is used to take into account thermal withstand with locked rotors. This second set of parameters is taken into account when the current is greater than an adjustable set point Is.

**Accounting for negative sequence current**

In the case of motors with coiled rotors, the presence of a negative sequence component increases the heat rise in the motor. The negative sequence component of the current is taken into account in the protection by the equation

$Ieq = \sqrt{Iph^2 + K \cdot Ii^2}$ in whichIph is the greatest phase current
Ii is the negative sequence component of the current
K is an adjustable factor

K may have the following values: 0 - 2.25 - 4.5 - 9
For an asynchronous motor, K is determined as follows:

$K = 2\frac{Cd}{Cn} \cdot \frac{1}{\left(\frac{Id}{Ib}\right)} - 1$ in whichCn, Cd: rated torque and starting torque
Ib, Id: basis current and starting current
g: rated slip.

**Learning of the cooling time constant T2**

The cooling time constant T2 may be learnt according to the temperatures measured in the equipment by temperature sensors connected to the MET148-2 module.
T2 is calculated every time that the equipment runs for a sufficient time, followed by a shutdown (I < 0.1Ib) and temperature stabilization.
For motors and generators, T2 is calculated according to the temperatures measured on the stator by RTDs 1, 2 and 3.
For transformers, T2 is calculated according to the temperatures measured on the primary winding by RTDs 1, 3 and 5.
For better accuracy, it is advisable to measure the ambient temperature with RTD 8.
If in the RTD assignment table, "other applications" is selected, T2 is not calculated.
Once the calculation has been made, the calculated value may be used to replace the T2 (1) parameter in two ways according to the configuration:

- automatically, in which case each new calculated value updates the T2 constant used
- or manually by entering the value in the T2 parameter.

***(1)*** *It is advisable to use the calculated T2 if the equipment has carried out at least three starting cycles followed by cooling.*

# Thermal overload
## ANSI code 49 RMS

**Start inhibit**
The thermal overload protection can inhibit the closing of the motor's control device until the heat rise drops back down below a value that allows restarting.
This value takes into account the heat rise produced by the motor when starting.
The inhibition function is grouped together with the **starts per hour** protection and the indication START INHIBIT informs the user.

**Saving of heat rise**
The current heat rise is saved in the event of an auxiliary power failure.

**Inhibition of tripping**
Tripping of the thermal overload protection may be inhibited by the logic input "Inhibit thermal overload" when required by the process.

**Use of two operating rates**
The thermal overload protection function may be used to protect equipment with two operating rates, for example:
- transformers with two ventilation modes, with or without forced ventilation (ONAN / ONAF)
- two-speed motors.

The protection function comprises two groups of settings, and each group is suitable for equipment protection in one of the two operating rates.
The equipment's basis current, used to calculate heat rise, also depends on the operating rate:
- with rate 1, the basis current Ib, defined as a general Sepam parameter, is used to calculate the heat rise in the equipment
- with rate 2, the basis current Ib-rate 2, a specific thermal overload protection setting, is used to calculate the heat rise in the equipment.

Switching from one group of thermal settings to the other is done without losing the heat rise value. It is controlled:
- either via a logic input, assigned to the "switching of thermal settings" function
- or when the phase current reaches an adjustable Is set point (to be used to process the switching of thermal settings of a motor with locked rotor).

**User information**
The following information is available for the user:
- heat rise
- learnt cooling time constant T2
- time before restart enabled (in case of inhibition of starting)
- time before tripping (with constant current).

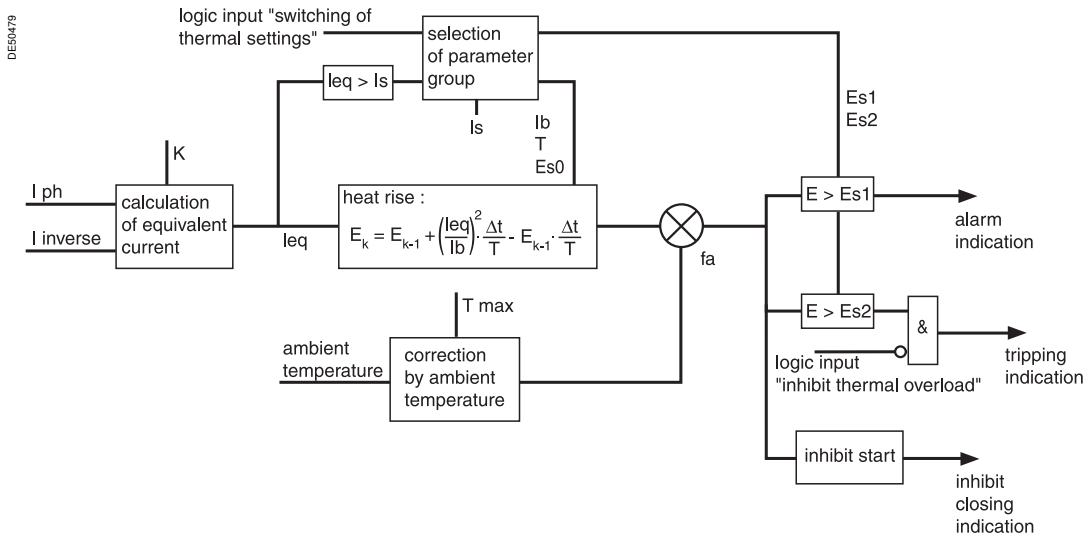
See chapter "Machine operation assistance functions", page 37.

## Characteristics

| **Set point** | | **Rate 1** | **Rate 2** |
|---|---|---|---|
| Setting | Es1 alarm set point | 50 % to 300 % | 50 % to 300 % |
| | Es2 tripping set point | 50 % to 300% | 50 % to 300 % |
| | Es0 initial heat rise | 0 to 100 % | 0 to 100 % |
| Resolution | | 1 % | 1 % |
| **Time constants** | | | |
| Setting | T1 running (heat rise) | 1 mn to 600 mn | 1 mn to 600 mn |
| | T2 stopped (cooling) | 5 mn to 600 mn | 5 mn to 600 mn |
| Resolution | | 1 mn | 1 mn |
| **Accounting for negative sequence component** | | | |
| Setting | K | 0 - 2.25 - 4.5 - 9 | |
| **Maximum equipment temperature (according to insulation class) (2)** | | | |
| Setting | | Tmax 60° à 200° | |
| Resolution | | 1° | |
| **Tripping time** | | | |
| Accuracy (1) | | ±2 % or 1 s | |
| **RMS current measurement** | | | |
| Accuracy | | ±5 % | |
| **Change of operating rate** | | | |
| By current threshold Is | Setting | 0.25 to 8 Ib | |
| By logic input "Switching of thermal settings" | | | |
| **Basis current for thermal operating rate 2** | | | |
| Setting | | 0.2 to 2.6 In | |
| **Use of learnt cooling time constant (T2)** | | | |
| Setting | | Yes / no | |

***(1)*** *In reference conditions (IEC 60255-6).*
***(2)*** *Equipment manufacturer data.*

## Block diagram



# Thermal overload
## ANSI code 49 RMS
## Setting examples

### Example 1

The following data are available:

- time constants for on operation T1 and off operation T2:
  - T1 = 25 min
  - T2 = 70 min
- maximum curve in steady state: Imax/Ib = 1.05.

**Setting of tripping set point Es2**

Es2 = $(Imax/Ib)^2$ = 110 %

***Note:*** *If the motor absorbs a current of 1.05 Ib in steady state, the heat rise calculated by the thermal overload protection will reach 110 %.*

**Setting of alarm set point Es1**

Es1 = 90 % (I/Ib = 0.95).

Knegative: 4.5 (usual value)

The other thermal overload parameters do not need to be set. They are not taken into account by default.

### Example 2

The following data are available:

- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1)
- cooling time constant T2
- maximum steady state current: Imax/Ib = 1.05.

**Setting of tripping set point Es2**

Es2 = $(Imax/Ib)^2$ = 110 %

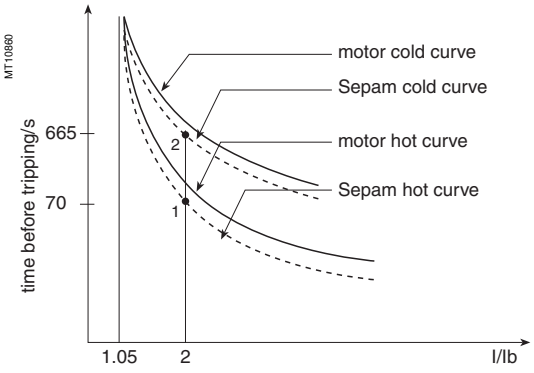
**Setting of alarm set point Es1:**

Es1 = 90 % (I/Ib = 0.95).

The manufacturer's hot/cold curves (1) may be used to determine the heating time constant T1.

The method consists of placing the Sepam hot/cold curves below those of the motor.

**Figure 1: motor thermal resistance and thermal overload tripping curves**




For an overload of 2*Ib, the value t/T1 = 0.0339 (2) is obtained.

In order for Sepam to trip at the point 1 (t = 70 s), T1 is equal to 2065 sec ≈ 34 min.

With a setting of T1 = 34 min, the tripping time is obtained based on a cold state (point 2). In this case, it is equal to t/T1 = 0.3216 ⇒ t ⇒ 665 sec, i.e. ≈ 11 min, which is compatible with the thermal resistance of the motor when cold.

The negative sequence factor is calculated using the equation defined on page 63.

The parameters of the second thermal overload relay do not need to be set. They are not taken into account by default.

### Example 3

The following data are available:

- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1),
- cooling time constant T2
- maximum steady state current: Imax/Ib = 1.1.

The thermal overload parameters are determined in the same way as in the previous example.

**Setting of tripping set point Es2**

Es2 = $(Imax/Ib)^2$ = 120 %

**Setting of alarm set point Es1**

Es1 = 90 % (I/Ib = 0.95).

The time constant T1 is calculated so that the thermal overload protection trips after 100 s (point 1).

With t/T1 = 0.069 (I/Ib = 2 and Es2 = 120 %):

⇒ T1 = 100s / 0.069 = 1449 sec ≈ 24 min.

The tripping time starting from the cold state is equal to:

t/T1 = 0.3567 ⇒ t = 24 min*0.3567 = 513 s (point 2').

This tripping time is too long since the limit for this overload current is 400 s (point 2).

If the time constant T1 is lowered, the thermal overload protection will trip earlier, below point 2.

There risk that motor starting when hot will not be possible also exists in this case (see Figure 2 in which a lower Sepam hot curve would intersect the starting curve with U = 0.9 Un).

The **Es0 parameter** is a setting that is used to solve these differences by lowering the Sepam cold curve without moving the hot curve.

In this example, the thermal overload protection should trip after 400 s starting from the cold state.

The following equation is used to obtain the Es0 value:

$$Es0 = \left[\frac{I_{processed}}{I_b}\right]^2 \frac{t_{necessary}}{T_1} - e \cdot \left[\left[\frac{I_{processed}}{I_b}\right]^2 - Es2\right]$$

with:

$t_{necessary}$: tripping time necessary starting from a cold state.

$I_{processed}$: equipment current.

*(1) When the machine manufacturer provides both a time constant T1 and the machine hot/cold curves, the use of the curves is recommended since they are more accurate.*

*(2) The charts containing the numerical values of the Sepam* ***hot curve*** *may be used, or else the equation of the curve which is given on page 63.*

# Thermal overload
## ANSI code 49 RMS
## Setting examples

In numerical values, the following is obtained:

$$Es0 = 4 - e^{\frac{400\ sec}{24 \times 60\ sec} \cdot [4 - 1.2]} = 0.3035 \approx 31\%$$

By setting Es0 = 31 %, point 2' is moved downward to obtain a shorter tripping time that is compatible with the motor's thermal resistance when cold (see Figure 3).

***Note:*** *A setting Es0 = 100 % therefore means that the hot and cold curves are the same.*

**Figure 2: hot/cold curves not compatible with the motor's thermal resistance**

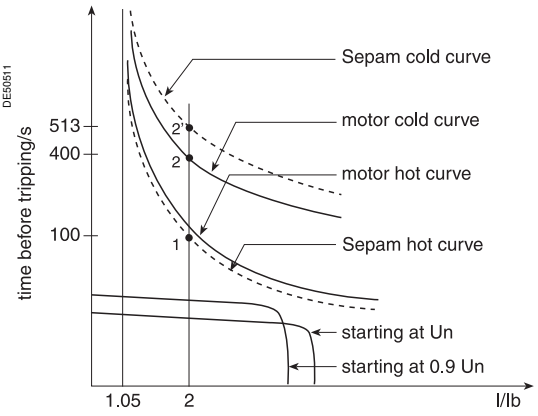
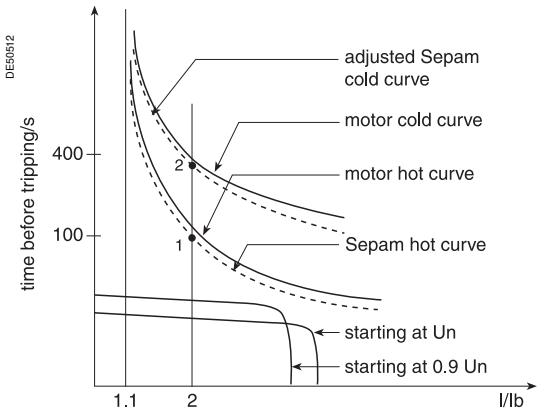



**Figure 3: hot/cold curves compatible with the motor's thermal resistance via the setting of an initial heat rise Es0**




**Use of the additional setting group**

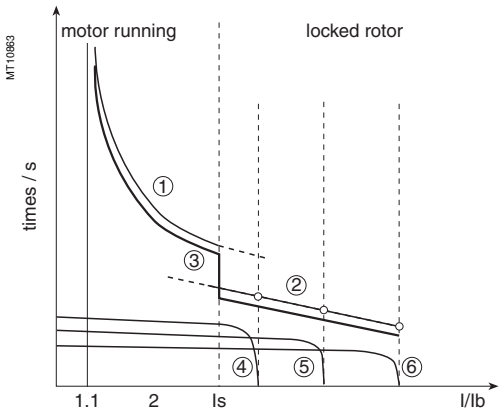
When a motor rotor is locked or is turning very slowly, its thermal behavior is different from that with the rated load. In such conditions, the motor is damaged by overheating of the rotor or stator. For high power motors, rotor overheating is most often a limiting factor.

The thermal overload parameters chosen for operation with a low overload are no longer valid.

In order to protect the motor in this case, "excessive starting time" protection may be used.

Nevertheless, motor manufacturers provide the thermal resistance curves when the rotor is locked, for different voltages at the time of starting.

**Figure 4: Locked rotor thermal resistance**




①: thermal resistance, motor running
②: thermal resistance, motor stopped
③: Sepam tripping curve
④: starting at 65 % Un
⑤: starting at 80 % Un
⑥: starting at 100 % Un

In order to take these curves into account, the second thermal overload relay may be used.

The time constant in this case is, in theory, the shortest one: however, it should not be determined in the same way as that of the first relay.

The thermal overload protection switches between the first and second relay if the equivalent current Ieq exceeds the Is value (set point current).

### Example 4: transformer with 2 ventilation modes

Given the following data:

The rated current of a transformer with 2 ventilation modes is:

- Ib = 200 A without forced ventilation (ONAN mode), the transformer's main operating rate
- Ib = 240 A with forced ventilation (ONAF mode), a temporary operating rate, to have 20 % more power available

Setting of the basis current for ventilation operating rate 1: Ib = 200 A
(to be set in Sepam general parameters).

Setting of the basis current for ventilation operating rate 2: Ib2 = 240 A
(to be set among the specific thermal overload protection settings).

Switching of thermal settings via logic input, to be assigned to the "switching of thermal settings" function and to be connected to the transformer ventilation control unit.

The settings related to each ventilation operating rate (Es set points, time constants, etc.) are to be determined according to the transformer characteristics provided by the manufacturer.

# Thermal overload
## ANSI code 49 RMS
## Setting examples

### Cold curves for Es0 = 0 %

| I/Ib<br>Es (%) | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.25 | 1.30 | 1.35 | 1.40 | 1.45 | 1.50 | 1.55 | 1.60 | 1.65 | 1.70 | 1.75 | 1.80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50** | 0.6931 | 0.6042 | 0.5331 | 0.4749 | 0.4265 | 0.3857 | 0.3508 | 0.3207 | 0.2945 | 0.2716 | 0.2513 | 0.2333 | 0.2173 | 0.2029 | 0.1900 | 0.1782 | 0.1676 |
| **55** | 0.7985 | 0.6909 | 0.6061 | 0.5376 | 0.4812 | 0.4339 | 0.3937 | 0.3592 | 0.3294 | 0.3033 | 0.2803 | 0.2600 | 0.2419 | 0.2257 | 0.2111 | 0.1980 | 0.1860 |
| **60** | 0.9163 | 0.7857 | 0.6849 | 0.6046 | 0.5390 | 0.4845 | 0.4386 | 0.3993 | 0.3655 | 0.3360 | 0.3102 | 0.2873 | 0.2671 | 0.2490 | 0.2327 | 0.2181 | 0.2048 |
| **65** | 1.0498 | 0.8905 | 0.7704 | 0.6763 | 0.6004 | 0.5379 | 0.4855 | 0.4411 | 0.4029 | 0.3698 | 0.3409 | 0.3155 | 0.2929 | 0.2728 | 0.2548 | 0.2386 | 0.2239 |
| **70** | 1.2040 | 1.0076 | 0.8640 | 0.7535 | 0.6657 | 0.5942 | 0.5348 | 0.4847 | 0.4418 | 0.4049 | 0.3727 | 0.3444 | 0.3194 | 0.2972 | 0.2774 | 0.2595 | 0.2434 |
| **75** | 1.3863 | 1.1403 | 0.9671 | 0.8373 | 0.7357 | 0.6539 | 0.5866 | 0.5302 | 0.4823 | 0.4412 | 0.4055 | 0.3742 | 0.3467 | 0.3222 | 0.3005 | 0.2809 | 0.2633 |
| **80** | 1.6094 | 1.2933 | 1.0822 | 0.9287 | 0.8109 | 0.7174 | 0.6413 | 0.5780 | 0.5245 | 0.4788 | 0.4394 | 0.4049 | 0.3747 | 0.3479 | 0.3241 | 0.3028 | 0.2836 |
| **85** | 1.8971 | 1.4739 | 1.2123 | 1.0292 | 0.8923 | 0.7853 | 0.6991 | 0.6281 | 0.5686 | 0.5180 | 0.4745 | 0.4366 | 0.4035 | 0.3743 | 0.3483 | 0.3251 | 0.3043 |
| **90** | 2.3026 | 1.6946 | 1.3618 | 1.1411 | 0.9808 | 0.8580 | 0.7605 | 0.6809 | 0.6147 | 0.5587 | 0.5108 | 0.4694 | 0.4332 | 0.4013 | 0.3731 | 0.3480 | 0.3254 |
| **95** | | 1.9782 | 1.5377 | 1.2670 | 1.0780 | 0.9365 | 0.8258 | 0.7366 | 0.6630 | 0.6012 | 0.5486 | 0.5032 | 0.4638 | 0.4292 | 0.3986 | 0.3714 | 0.3470 |
| **100** | | 2.3755 | 1.7513 | 1.4112 | 1.1856 | 1.0217 | 0.8958 | 0.7956 | 0.7138 | 0.6455 | 0.5878 | 0.5383 | 0.4953 | 0.4578 | 0.4247 | 0.3953 | 0.3691 |
| **105** | | 3.0445 | 2.0232 | 1.5796 | 1.3063 | 1.1147 | 0.9710 | 0.8583 | 0.7673 | 0.6920 | 0.6286 | 0.5746 | 0.5279 | 0.4872 | 0.4515 | 0.4199 | 0.3917 |
| **110** | | | 2.3979 | 1.7824 | 1.4435 | 1.2174 | 1.0524 | 0.9252 | 0.8238 | 0.7406 | 0.6712 | 0.6122 | 0.5616 | 0.5176 | 0.4790 | 0.4450 | 0.4148 |
| **115** | | | 3.0040 | 2.0369 | 1.6025 | 1.3318 | 1.1409 | 0.9970 | 0.8837 | 0.7918 | 0.7156 | 0.6514 | 0.5964 | 0.5489 | 0.5074 | 0.4708 | 0.4384 |
| **120** | | | | 2.3792 | 1.7918 | 1.4610 | 1.2381 | 1.0742 | 0.9474 | 0.8457 | 0.7621 | 0.6921 | 0.6325 | 0.5812 | 0.5365 | 0.4973 | 0.4626 |
| **125** | | | | 2.9037 | 2.0254 | 1.6094 | 1.3457 | 1.1580 | 1.0154 | 0.9027 | 0.8109 | 0.7346 | 0.6700 | 0.6146 | 0.5666 | 0.5245 | 0.4874 |
| **130** | | | | | 2.3308 | 1.7838 | 1.4663 | 1.2493 | 1.0885 | 0.9632 | 0.8622 | 0.7789 | 0.7089 | 0.6491 | 0.5975 | 0.5525 | 0.5129 |
| **135** | | | | | 2.7726 | 1.9951 | 1.6035 | 1.3499 | 1.1672 | 1.0275 | 0.9163 | 0.8253 | 0.7494 | 0.6849 | 0.6295 | 0.5813 | 0.5390 |
| **140** | | | | | | 2.2634 | 1.7626 | 1.4618 | 1.2528 | 1.0962 | 0.9734 | 0.8740 | 0.7916 | 0.7220 | 0.6625 | 0.6109 | 0.5658 |
| **145** | | | | | | 2.6311 | 1.9518 | 1.5877 | 1.3463 | 1.1701 | 1.0341 | 0.9252 | 0.8356 | 0.7606 | 0.6966 | 0.6414 | 0.5934 |
| **150** | | | | | | 3.2189 | 2.1855 | 1.7319 | 1.4495 | 1.2498 | 1.0986 | 0.9791 | 0.8817 | 0.8007 | 0.7320 | 0.6729 | 0.6217 |
| **155** | | | | | | | 2.4908 | 1.9003 | 1.5645 | 1.3364 | 1.1676 | 1.0361 | 0.9301 | 0.8424 | 0.7686 | 0.7055 | 0.6508 |
| **160** | | | | | | | 2.9327 | 2.1030 | 1.6946 | 1.4313 | 1.2417 | 1.0965 | 0.9808 | 0.8860 | 0.8066 | 0.7391 | 0.6809 |
| **165** | | | | | | | | 2.3576 | 1.8441 | 1.5361 | 1.3218 | 1.1609 | 1.0343 | 0.9316 | 0.8461 | 0.7739 | 0.7118 |
| **170** | | | | | | | | 2.6999 | 2.0200 | 1.6532 | 1.4088 | 1.2296 | 1.0908 | 0.9793 | 0.8873 | 0.8099 | 0.7438 |
| **175** | | | | | | | | 3.2244 | 2.2336 | 1.7858 | 1.5041 | 1.3035 | 1.1507 | 1.0294 | 0.9302 | 0.8473 | 0.7768 |
| **180** | | | | | | | | | 2.5055 | 1.9388 | 1.6094 | 1.3832 | 1.2144 | 1.0822 | 0.9751 | 0.8861 | 0.8109 |
| **185** | | | | | | | | | 2.8802 | 2.1195 | 1.7272 | 1.4698 | 1.2825 | 1.1379 | 1.0220 | 0.9265 | 0.8463 |
| **190** | | | | | | | | | 3.4864 | 2.3401 | 1.8608 | 1.5647 | 1.3555 | 1.1970 | 1.0713 | 0.9687 | 0.8829 |
| **195** | | | | | | | | | | 2.6237 | 2.0149 | 1.6695 | 1.4343 | 1.2597 | 1.1231 | 1.0126 | 0.9209 |
| **200** | | | | | | | | | | 3.0210 | 2.1972 | 1.7866 | 1.5198 | 1.3266 | 1.1778 | 1.0586 | 0.9605 |

# Thermal overload
## ANSI code 49 RMS
## Setting examples



### Cold curves for Es0 = 0 %

| I/Ib<br>Es (%) | 1.85 | 1.90 | 1.95 | 2.00 | 2.20 | 2.40 | 2.60 | 2.80 | 3.00 | 3.20 | 3.40 | 3.60 | 3.80 | 4.00 | 4.20 | 4.40 | 4.60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50** | 0.1579 | 0.1491 | 0.1410 | 0.1335 | 0.1090 | 0.0908 | 0.0768 | 0.0659 | 0.0572 | 0.0501 | 0.0442 | 0.0393 | 0.0352 | 0.0317 | 0.0288 | 0.0262 | 0.0239 |
| **55** | 0.1752 | 0.1653 | 0.1562 | 0.1479 | 0.1206 | 0.1004 | 0.0849 | 0.0727 | 0.0631 | 0.0552 | 0.0487 | 0.0434 | 0.0388 | 0.0350 | 0.0317 | 0.0288 | 0.0263 |
| **60** | 0.1927 | 0.1818 | 0.1717 | 0.1625 | 0.1324 | 0.1100 | 0.0929 | 0.0796 | 0.069 | 0.0604 | 0.0533 | 0.0474 | 0.0424 | 0.0382 | 0.0346 | 0.0315 | 0.0288 |
| **65** | 0.2106 | 0.1985 | 0.1875 | 0.1773 | 0.1442 | 0.1197 | 0.1011 | 0.0865 | 0.075 | 0.0656 | 0.0579 | 0.0515 | 0.0461 | 0.0415 | 0.0375 | 0.0342 | 0.0312 |
| **70** | 0.2288 | 0.2156 | 0.2035 | 0.1924 | 0.1562 | 0.1296 | 0.1093 | 0.0935 | 0.081 | 0.0708 | 0.0625 | 0.0555 | 0.0497 | 0.0447 | 0.0405 | 0.0368 | 0.0336 |
| **75** | 0.2474 | 0.2329 | 0.2197 | 0.2076 | 0.1684 | 0.1395 | 0.1176 | 0.1006 | 0.087 | 0.0761 | 0.0671 | 0.0596 | 0.0533 | 0.0480 | 0.0434 | 0.0395 | 0.0361 |
| **80** | 0.2662 | 0.2505 | 0.2362 | 0.2231 | 0.1807 | 0.1495 | 0.1260 | 0.1076 | 0.0931 | 0.0813 | 0.0717 | 0.0637 | 0.0570 | 0.0513 | 0.0464 | 0.0422 | 0.0385 |
| **85** | 0.2855 | 0.2685 | 0.2530 | 0.2389 | 0.1931 | 0.1597 | 0.1344 | 0.1148 | 0.0992 | 0.0867 | 0.0764 | 0.0678 | 0.0607 | 0.0546 | 0.0494 | 0.0449 | 0.0410 |
| **90** | 0.3051 | 0.2868 | 0.2701 | 0.2549 | 0.2057 | 0.1699 | 0.1429 | 0.1219 | 0.1054 | 0.092 | 0.0811 | 0.0720 | 0.0644 | 0.0579 | 0.0524 | 0.0476 | 0.0435 |
| **95** | 0.3251 | 0.3054 | 0.2875 | 0.2712 | 0.2185 | 0.1802 | 0.1514 | 0.1292 | 0.1116 | 0.0974 | 0.0858 | 0.0761 | 0.0681 | 0.0612 | 0.0554 | 0.0503 | 0.0459 |
| **100** | 0.3456 | 0.3244 | 0.3051 | 0.2877 | 0.2314 | 0.1907 | 0.1601 | 0.1365 | 0.1178 | 0.1028 | 0.0905 | 0.0803 | 0.0718 | 0.0645 | 0.0584 | 0.0530 | 0.0484 |
| **105** | 0.3664 | 0.3437 | 0.3231 | 0.3045 | 0.2445 | 0.2012 | 0.1688 | 0.1438 | 0.1241 | 0.1082 | 0.0952 | 0.0845 | 0.0755 | 0.0679 | 0.0614 | 0.0558 | 0.0509 |
| **110** | 0.3877 | 0.3634 | 0.3415 | 0.3216 | 0.2578 | 0.2119 | 0.1776 | 0.1512 | 0.1304 | 0.1136 | 0.1000 | 0.0887 | 0.0792 | 0.0712 | 0.0644 | 0.0585 | 0.0534 |
| **115** | 0.4095 | 0.3835 | 0.3602 | 0.3390 | 0.2713 | 0.2227 | 0.1865 | 0.1586 | 0.1367 | 0.1191 | 0.1048 | 0.0929 | 0.0830 | 0.0746 | 0.0674 | 0.0612 | 0.0559 |
| **120** | 0.4317 | 0.4041 | 0.3792 | 0.3567 | 0.2849 | 0.2336 | 0.1954 | 0.1661 | 0.1431 | 0.1246 | 0.1096 | 0.0972 | 0.0868 | 0.0780 | 0.0705 | 0.0640 | 0.0584 |
| **125** | 0.4545 | 0.4250 | 0.3986 | 0.3747 | 0.2988 | 0.2446 | 0.2045 | 0.1737 | 0.1495 | 0.1302 | 0.1144 | 0.1014 | 0.0905 | 0.0813 | 0.0735 | 0.0667 | 0.0609 |
| **130** | 0.4778 | 0.4465 | 0.4184 | 0.3930 | 0.3128 | 0.2558 | 0.2136 | 0.1813 | 0.156 | 0.1358 | 0.1193 | 0.1057 | 0.0943 | 0.0847 | 0.0766 | 0.0695 | 0.0634 |
| **135** | 0.5016 | 0.4683 | 0.4386 | 0.4117 | 0.3270 | 0.2671 | 0.2228 | 0.1890 | 0.1625 | 0.1414 | 0.1242 | 0.1100 | 0.0982 | 0.0881 | 0.0796 | 0.0723 | 0.0659 |
| **140** | 0.5260 | 0.4907 | 0.4591 | 0.4308 | 0.3414 | 0.2785 | 0.2321 | 0.1967 | 0.1691 | 0.147 | 0.1291 | 0.1143 | 0.1020 | 0.0916 | 0.0827 | 0.0751 | 0.0685 |
| **145** | 0.5511 | 0.5136 | 0.4802 | 0.4502 | 0.3561 | 0.2900 | 0.2414 | 0.2045 | 0.1757 | 0.1527 | 0.1340 | 0.1187 | 0.1058 | 0.0950 | 0.0858 | 0.0778 | 0.0710 |
| **150** | 0.5767 | 0.5370 | 0.5017 | 0.4700 | 0.3709 | 0.3017 | 0.2509 | 0.2124 | 0.1823 | 0.1584 | 0.1390 | 0.1230 | 0.1097 | 0.0984 | 0.0889 | 0.0806 | 0.0735 |
| **155** | 0.6031 | 0.5610 | 0.5236 | 0.4902 | 0.3860 | 0.3135 | 0.2604 | 0.2203 | 0.189 | 0.1641 | 0.1440 | 0.1274 | 0.1136 | 0.1019 | 0.0920 | 0.0834 | 0.0761 |
| **160** | 0.6302 | 0.5856 | 0.5461 | 0.5108 | 0.4013 | 0.3254 | 0.2701 | 0.2283 | 0.1957 | 0.1699 | 0.1490 | 0.1318 | 0.1174 | 0.1054 | 0.0951 | 0.0863 | 0.0786 |
| **165** | 0.6580 | 0.6108 | 0.5690 | 0.5319 | 0.4169 | 0.3375 | 0.2798 | 0.2363 | 0.2025 | 0.1757 | 0.1540 | 0.1362 | 0.1213 | 0.1088 | 0.0982 | 0.0891 | 0.0812 |
| **170** | 0.6866 | 0.6366 | 0.5925 | 0.5534 | 0.4327 | 0.3498 | 0.2897 | 0.2444 | 0.2094 | 0.1815 | 0.1591 | 0.1406 | 0.1253 | 0.1123 | 0.1013 | 0.0919 | 0.0838 |
| **175** | 0.7161 | 0.6631 | 0.6166 | 0.5754 | 0.4487 | 0.3621 | 0.2996 | 0.2526 | 0.2162 | 0.1874 | 0.1641 | 0.1451 | 0.1292 | 0.1158 | 0.1045 | 0.0947 | 0.0863 |
| **180** | 0.7464 | 0.6904 | 0.6413 | 0.5978 | 0.4651 | 0.3747 | 0.3096 | 0.2608 | 0.2231 | 0.1933 | 0.1693 | 0.1495 | 0.1331 | 0.1193 | 0.1076 | 0.0976 | 0.0889 |
| **185** | 0.7777 | 0.7184 | 0.6665 | 0.6208 | 0.4816 | 0.3874 | 0.3197 | 0.2691 | 0.2301 | 0.1993 | 0.1744 | 0.1540 | 0.1371 | 0.1229 | 0.1108 | 0.1004 | 0.0915 |
| **190** | 0.8100 | 0.7472 | 0.6925 | 0.6444 | 0.4985 | 0.4003 | 0.3300 | 0.2775 | 0.2371 | 0.2052 | 0.1796 | 0.1585 | 0.1411 | 0.1264 | 0.1140 | 0.1033 | 0.0941 |
| **195** | 0.8434 | 0.7769 | 0.7191 | 0.6685 | 0.5157 | 0.4133 | 0.3403 | 0.2860 | 0.2442 | 0.2113 | 0.1847 | 0.1631 | 0.1451 | 0.1300 | 0.1171 | 0.1062 | 0.0967 |
| **200** | 0.8780 | 0.8075 | 0.7465 | 0.6931 | 0.5331 | 0.4265 | 0.3508 | 0.2945 | 0.2513 | 0.2173 | 0.1900 | 0.1676 | 0.1491 | 0.1335 | 0.1203 | 0.1090 | 0.0993 |

# Thermal overload
## ANSI code 49 RMS
## Setting examples

### Cold curves for Es0 = 0 %

| I/Ib<br>Es (%) | 4.80 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 | 8.50 | 9.00 | 9.50 | 10.00 | 12.50 | 15.00 | 17.50 | 20.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50** | 0.0219 | 0.0202 | 0.0167 | 0.0140 | 0.0119 | 0.0103 | 0.0089 | 0.0078 | 0.0069 | 0.0062 | 0.0056 | 0.0050 | 0.0032 | 0.0022 | 0.0016 | 0.0013 |
| **55** | 0.0242 | 0.0222 | 0.0183 | 0.0154 | 0.0131 | 0.0113 | 0.0098 | 0.0086 | 0.0076 | 0.0068 | 0.0061 | 0.0055 | 0.0035 | 0.0024 | 0.0018 | 0.0014 |
| **60** | 0.0264 | 0.0243 | 0.0200 | 0.0168 | 0.0143 | 0.0123 | 0.0107 | 0.0094 | 0.0083 | 0.0074 | 0.0067 | 0.0060 | 0.0038 | 0.0027 | 0.0020 | 0.0015 |
| **65** | 0.0286 | 0.0263 | 0.0217 | 0.0182 | 0.0155 | 0.0134 | 0.0116 | 0.0102 | 0.0090 | 0.0081 | 0.0072 | 0.0065 | 0.0042 | 0.0029 | 0.0021 | 0.0016 |
| **70** | 0.0309 | 0.0284 | 0.0234 | 0.0196 | 0.0167 | 0.0144 | 0.0125 | 0.0110 | 0.0097 | 0.0087 | 0.0078 | 0.0070 | 0.0045 | 0.0031 | 0.0023 | 0.0018 |
| **75** | 0.0331 | 0.0305 | 0.0251 | 0.0211 | 0.0179 | 0.0154 | 0.0134 | 0.0118 | 0.0104 | 0.0093 | 0.0083 | 0.0075 | 0.0048 | 0.0033 | 0.0025 | 0.0019 |
| **80** | 0.0353 | 0.0325 | 0.0268 | 0.0225 | 0.0191 | 0.0165 | 0.0143 | 0.0126 | 0.0111 | 0.0099 | 0.0089 | 0.0080 | 0.0051 | 0.0036 | 0.0026 | 0.0020 |
| **85** | 0.0376 | 0.0346 | 0.0285 | 0.0239 | 0.0203 | 0.0175 | 0.0152 | 0.0134 | 0.0118 | 0.0105 | 0.0095 | 0.0085 | 0.0055 | 0.0038 | 0.0028 | 0.0021 |
| **90** | 0.0398 | 0.0367 | 0.0302 | 0.0253 | 0.0215 | 0.0185 | 0.0161 | 0.0142 | 0.0125 | 0.0112 | 0.0100 | 0.0090 | 0.0058 | 0.0040 | 0.0029 | 0.0023 |
| **95** | 0.0421 | 0.0387 | 0.0319 | 0.0267 | 0.0227 | 0.0196 | 0.0170 | 0.0150 | 0.0132 | 0.0118 | 0.0106 | 0.0095 | 0.0061 | 0.0042 | 0.0031 | 0.0024 |
| **100** | 0.0444 | 0.0408 | 0.0336 | 0.0282 | 0.0240 | 0.0206 | 0.0179 | 0.0157 | 0.0139 | 0.0124 | 0.0111 | 0.0101 | 0.0064 | 0.0045 | 0.0033 | 0.0025 |
| **105** | 0.0466 | 0.0429 | 0.0353 | 0.0296 | 0.0252 | 0.0217 | 0.0188 | 0.0165 | 0.0146 | 0.0130 | 0.0117 | 0.0106 | 0.0067 | 0.0047 | 0.0034 | 0.0026 |
| **110** | 0.0489 | 0.0450 | 0.0370 | 0.0310 | 0.0264 | 0.0227 | 0.0197 | 0.0173 | 0.0153 | 0.0137 | 0.0123 | 0.0111 | 0.0071 | 0.0049 | 0.0036 | 0.0028 |
| **115** | 0.0512 | 0.0471 | 0.0388 | 0.0325 | 0.0276 | 0.0237 | 0.0207 | 0.0181 | 0.0160 | 0.0143 | 0.0128 | 0.0116 | 0.0074 | 0.0051 | 0.0038 | 0.0029 |
| **120** | 0.0535 | 0.0492 | 0.0405 | 0.0339 | 0.0288 | 0.0248 | 0.0216 | 0.0189 | 0.0167 | 0.0149 | 0.0134 | 0.0121 | 0.0077 | 0.0053 | 0.0039 | 0.0030 |
| **125** | 0.0558 | 0.0513 | 0.0422 | 0.0353 | 0.0300 | 0.0258 | 0.0225 | 0.0197 | 0.0175 | 0.0156 | 0.0139 | 0.0126 | 0.0080 | 0.0056 | 0.0041 | 0.0031 |
| **130** | 0.0581 | 0.0534 | 0.0439 | 0.0368 | 0.0313 | 0.0269 | 0.0234 | 0.0205 | 0.0182 | 0.0162 | 0.0145 | 0.0131 | 0.0084 | 0.0058 | 0.0043 | 0.0033 |
| **135** | 0.0604 | 0.0555 | 0.0457 | 0.0382 | 0.0325 | 0.0279 | 0.0243 | 0.0213 | 0.0189 | 0.0168 | 0.0151 | 0.0136 | 0.0087 | 0.0060 | 0.0044 | 0.0034 |
| **140** | 0.0627 | 0.0576 | 0.0474 | 0.0397 | 0.0337 | 0.0290 | 0.0252 | 0.0221 | 0.0196 | 0.0174 | 0.0156 | 0.0141 | 0.0090 | 0.0062 | 0.0046 | 0.0035 |
| **145** | 0.0650 | 0.0598 | 0.0491 | 0.0411 | 0.0349 | 0.0300 | 0.0261 | 0.0229 | 0.0203 | 0.0181 | 0.0162 | 0.0146 | 0.0093 | 0.0065 | 0.0047 | 0.0036 |
| **150** | 0.0673 | 0.0619 | 0.0509 | 0.0426 | 0.0361 | 0.0311 | 0.0270 | 0.0237 | 0.0210 | 0.0187 | 0.0168 | 0.0151 | 0.0096 | 0.0067 | 0.0049 | 0.0038 |
| **155** | 0.0696 | 0.0640 | 0.0526 | 0.0440 | 0.0374 | 0.0321 | 0.0279 | 0.0245 | 0.0217 | 0.0193 | 0.0173 | 0.0156 | 0.0100 | 0.0069 | 0.0051 | 0.0039 |
| **160** | 0.0720 | 0.0661 | 0.0543 | 0.0455 | 0.0386 | 0.0332 | 0.0289 | 0.0253 | 0.0224 | 0.0200 | 0.0179 | 0.0161 | 0.0103 | 0.0071 | 0.0052 | 0.0040 |
| **165** | 0.0743 | 0.0683 | 0.0561 | 0.0469 | 0.0398 | 0.0343 | 0.0298 | 0.0261 | 0.0231 | 0.0206 | 0.0185 | 0.0166 | 0.0106 | 0.0074 | 0.0054 | 0.0041 |
| **170** | 0.0766 | 0.0704 | 0.0578 | 0.0484 | 0.0411 | 0.0353 | 0.0307 | 0.0269 | 0.0238 | 0.0212 | 0.0190 | 0.0171 | 0.0109 | 0.0076 | 0.0056 | 0.0043 |
| **175** | 0.0790 | 0.0726 | 0.0596 | 0.0498 | 0.0423 | 0.0364 | 0.0316 | 0.0277 | 0.0245 | 0.0218 | 0.0196 | 0.0177 | 0.0113 | 0.0078 | 0.0057 | 0.0044 |
| **180** | 0.0813 | 0.0747 | 0.0613 | 0.0513 | 0.0435 | 0.0374 | 0.0325 | 0.0285 | 0.0252 | 0.0225 | 0.0201 | 0.0182 | 0.0116 | 0.0080 | 0.0059 | 0.0045 |
| **185** | 0.0837 | 0.0769 | 0.0631 | 0.0528 | 0.0448 | 0.0385 | 0.0334 | 0.0293 | 0.0259 | 0.0231 | 0.0207 | 0.0187 | 0.0119 | 0.0083 | 0.0061 | 0.0046 |
| **190** | 0.0861 | 0.0790 | 0.0649 | 0.0542 | 0.0460 | 0.0395 | 0.0344 | 0.0301 | 0.0266 | 0.0237 | 0.0213 | 0.0192 | 0.0122 | 0.0085 | 0.0062 | 0.0048 |
| **195** | 0.0884 | 0.0812 | 0.0666 | 0.0557 | 0.0473 | 0.0406 | 0.0353 | 0.0309 | 0.0274 | 0.0244 | 0.0218 | 0.0197 | 0.0126 | 0.0087 | 0.0064 | 0.0049 |
| **200** | 0.0908 | 0.0834 | 0.0684 | 0.0572 | 0.0485 | 0.0417 | 0.0362 | 0.0317 | 0.0281 | 0.0250 | 0.0224 | 0.0202 | 0.0129 | 0.0089 | 0.0066 | 0.0050 |

# Thermal overload
## ANSI code 49 RMS
## Setting examples

### Hot curves

| I/Ib<br>Es (%) | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.25 | 1.30 | 1.35 | 1.40 | 1.45 | 1.50 | 1.55 | 1.60 | 1.65 | 1.70 | 1.75 | 1.80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **105** | | 0.6690 | 0.2719 | 0.1685 | 0.1206 | 0.0931 | 0.0752 | 0.0627 | 0.0535 | 0.0464 | 0.0408 | 0.0363 | 0.0326 | 0.0295 | 0.0268 | 0.0245 | 0.0226 |
| **110** | | 3.7136 | 0.6466 | 0.3712 | 0.2578 | 0.1957 | 0.1566 | 0.1296 | 0.1100 | 0.0951 | 0.0834 | 0.0740 | 0.0662 | 0.0598 | 0.0544 | 0.0497 | 0.0457 |
| **115** | | | 1.2528 | 0.6257 | 0.4169 | 0.3102 | 0.2451 | 0.2013 | 0.1699 | 0.1462 | 0.1278 | 0.1131 | 0.1011 | 0.0911 | 0.0827 | 0.0755 | 0.0693 |
| **120** | | | 3.0445 | 0.9680 | 0.6061 | 0.4394 | 0.3423 | 0.2786 | 0.2336 | 0.2002 | 0.1744 | 0.1539 | 0.1372 | 0.1234 | 0.1118 | 0.1020 | 0.0935 |
| **125** | | | | 1.4925 | 0.8398 | 0.5878 | 0.4499 | 0.3623 | 0.3017 | 0.2572 | 0.2231 | 0.1963 | 0.1747 | 0.1568 | 0.1419 | 0.1292 | 0.1183 |
| **130** | | | | 2.6626 | 1.1451 | 0.7621 | 0.5705 | 0.4537 | 0.3747 | 0.3176 | 0.2744 | 0.2407 | 0.2136 | 0.1914 | 0.1728 | 0.1572 | 0.1438 |
| **135** | | | | | 1.5870 | 0.9734 | 0.7077 | 0.5543 | 0.4535 | 0.3819 | 0.3285 | 0.2871 | 0.2541 | 0.2271 | 0.2048 | 0.1860 | 0.1699 |
| **140** | | | | | 2.3979 | 1.2417 | 0.8668 | 0.6662 | 0.5390 | 0.4507 | 0.3857 | 0.3358 | 0.2963 | 0.2643 | 0.2378 | 0.2156 | 0.1967 |
| **145** | | | | | | 1.6094 | 1.0561 | 0.7921 | 0.6325 | 0.5245 | 0.4463 | 0.3869 | 0.3403 | 0.3028 | 0.2719 | 0.2461 | 0.2243 |
| **150** | | | | | | 2.1972 | 1.2897 | 0.9362 | 0.7357 | 0.6042 | 0.5108 | 0.4408 | 0.3864 | 0.3429 | 0.3073 | 0.2776 | 0.2526 |
| **155** | | | | | | 3.8067 | 1.5950 | 1.1047 | 0.8508 | 0.6909 | 0.5798 | 0.4978 | 0.4347 | 0.3846 | 0.3439 | 0.3102 | 0.2817 |
| **160** | | | | | | | 2.0369 | 1.3074 | 0.9808 | 0.7857 | 0.6539 | 0.5583 | 0.4855 | 0.4282 | 0.3819 | 0.3438 | 0.3118 |
| **165** | | | | | | | 2.8478 | 1.5620 | 1.1304 | 0.8905 | 0.7340 | 0.6226 | 0.5390 | 0.4738 | 0.4215 | 0.3786 | 0.3427 |
| **170** | | | | | | | | 1.9042 | 1.3063 | 1.0076 | 0.8210 | 0.6914 | 0.5955 | 0.5215 | 0.4626 | 0.4146 | 0.3747 |
| **175** | | | | | | | | 2.4288 | 1.5198 | 1.1403 | 0.9163 | 0.7652 | 0.6554 | 0.5717 | 0.5055 | 0.4520 | 0.4077 |
| **180** | | | | | | | | 3.5988 | 1.7918 | 1.2933 | 1.0217 | 0.8449 | 0.7191 | 0.6244 | 0.5504 | 0.4908 | 0.4418 |
| **185** | | | | | | | | | 2.1665 | 1.4739 | 1.1394 | 0.9316 | 0.7872 | 0.6802 | 0.5974 | 0.5312 | 0.4772 |
| **190** | | | | | | | | | 2.7726 | 1.6946 | 1.2730 | 1.0264 | 0.8602 | 0.7392 | 0.6466 | 0.5733 | 0.5138 |
| **195** | | | | | | | | | 4.5643 | 1.9782 | 1.4271 | 1.1312 | 0.9390 | 0.8019 | 0.6985 | 0.6173 | 0.5518 |
| **200** | | | | | | | | | | 2.3755 | 1.6094 | 1.2483 | 1.0245 | 0.8688 | 0.7531 | 0.6633 | 0.5914 |

| I/Ib<br>Es (%) | 1.85 | 1.90 | 1.95 | 2.00 | 2.20 | 2.40 | 2.60 | 2.80 | 3.00 | 3.20 | 3.40 | 3.60 | 3.80 | 4.00 | 4.20 | 4.40 | 4.60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **105** | 0.0209 | 0.0193 | 0.0180 | 0.0168 | 0.0131 | 0.0106 | 0.0087 | 0.0073 | 0.0063 | 0.0054 | 0.0047 | 0.0042 | 0.0037 | 0.0033 | 0.0030 | 0.0027 | 0.0025 |
| **110** | 0.0422 | 0.0391 | 0.0363 | 0.0339 | 0.0264 | 0.0212 | 0.0175 | 0.0147 | 0.0126 | 0.0109 | 0.0095 | 0.0084 | 0.0075 | 0.0067 | 0.0060 | 0.0055 | 0.0050 |
| **115** | 0.0639 | 0.0592 | 0.0550 | 0.0513 | 0.0398 | 0.0320 | 0.0264 | 0.0222 | 0.0189 | 0.0164 | 0.0143 | 0.0126 | 0.0112 | 0.0101 | 0.0091 | 0.0082 | 0.0075 |
| **120** | 0.0862 | 0.0797 | 0.0740 | 0.0690 | 0.0535 | 0.0429 | 0.0353 | 0.0297 | 0.0253 | 0.0219 | 0.0191 | 0.0169 | 0.0150 | 0.0134 | 0.0121 | 0.0110 | 0.0100 |
| **125** | 0.1089 | 0.1007 | 0.0934 | 0.0870 | 0.0673 | 0.0540 | 0.0444 | 0.0372 | 0.0317 | 0.0274 | 0.0240 | 0.0211 | 0.0188 | 0.0168 | 0.0151 | 0.0137 | 0.0125 |
| **130** | 0.1322 | 0.1221 | 0.1132 | 0.1054 | 0.0813 | 0.0651 | 0.0535 | 0.0449 | 0.0382 | 0.0330 | 0.0288 | 0.0254 | 0.0226 | 0.0202 | 0.0182 | 0.0165 | 0.0150 |
| **135** | 0.1560 | 0.1440 | 0.1334 | 0.1241 | 0.0956 | 0.0764 | 0.0627 | 0.0525 | 0.0447 | 0.0386 | 0.0337 | 0.0297 | 0.0264 | 0.0236 | 0.0213 | 0.0192 | 0.0175 |
| **140** | 0.1805 | 0.1664 | 0.1540 | 0.1431 | 0.1100 | 0.0878 | 0.0720 | 0.0603 | 0.0513 | 0.0443 | 0.0386 | 0.0340 | 0.0302 | 0.0270 | 0.0243 | 0.0220 | 0.0200 |
| **145** | 0.2055 | 0.1892 | 0.1750 | 0.1625 | 0.1246 | 0.0993 | 0.0813 | 0.0681 | 0.0579 | 0.0499 | 0.0435 | 0.0384 | 0.0341 | 0.0305 | 0.0274 | 0.0248 | 0.0226 |
| **150** | 0.2312 | 0.2127 | 0.1965 | 0.1823 | 0.1395 | 0.1110 | 0.0908 | 0.0759 | 0.0645 | 0.0556 | 0.0485 | 0.0427 | 0.0379 | 0.0339 | 0.0305 | 0.0276 | 0.0251 |
| **155** | 0.2575 | 0.2366 | 0.2185 | 0.2025 | 0.1546 | 0.1228 | 0.1004 | 0.0838 | 0.0712 | 0.0614 | 0.0535 | 0.0471 | 0.0418 | 0.0374 | 0.0336 | 0.0304 | 0.0277 |
| **160** | 0.2846 | 0.2612 | 0.2409 | 0.2231 | 0.1699 | 0.1347 | 0.1100 | 0.0918 | 0.0780 | 0.0671 | 0.0585 | 0.0515 | 0.0457 | 0.0408 | 0.0367 | 0.0332 | 0.0302 |
| **165** | 0.3124 | 0.2864 | 0.2639 | 0.2442 | 0.1855 | 0.1468 | 0.1197 | 0.0999 | 0.0847 | 0.0729 | 0.0635 | 0.0559 | 0.0496 | 0.0443 | 0.0398 | 0.0360 | 0.0328 |
| **170** | 0.3410 | 0.3122 | 0.2874 | 0.2657 | 0.2012 | 0.1591 | 0.1296 | 0.1080 | 0.0916 | 0.0788 | 0.0686 | 0.0603 | 0.0535 | 0.0478 | 0.0430 | 0.0389 | 0.0353 |
| **175** | 0.3705 | 0.3388 | 0.3115 | 0.2877 | 0.2173 | 0.1715 | 0.1395 | 0.1161 | 0.0984 | 0.0847 | 0.0737 | 0.0648 | 0.0574 | 0.0513 | 0.0461 | 0.0417 | 0.0379 |
| **180** | 0.4008 | 0.3660 | 0.3361 | 0.3102 | 0.2336 | 0.1840 | 0.1495 | 0.1244 | 0.1054 | 0.0906 | 0.0788 | 0.0692 | 0.0614 | 0.0548 | 0.0493 | 0.0446 | 0.0405 |
| **185** | 0.4321 | 0.3940 | 0.3614 | 0.3331 | 0.2502 | 0.1967 | 0.1597 | 0.1327 | 0.1123 | 0.0965 | 0.0839 | 0.0737 | 0.0653 | 0.0583 | 0.0524 | 0.0474 | 0.0431 |
| **190** | 0.4644 | 0.4229 | 0.3873 | 0.3567 | 0.2671 | 0.2096 | 0.1699 | 0.1411 | 0.1193 | 0.1025 | 0.0891 | 0.0782 | 0.0693 | 0.0619 | 0.0556 | 0.0503 | 0.0457 |
| **195** | 0.4978 | 0.4525 | 0.4140 | 0.3808 | 0.2842 | 0.2226 | 0.1802 | 0.1495 | 0.1264 | 0.1085 | 0.0943 | 0.0828 | 0.0733 | 0.0654 | 0.0588 | 0.0531 | 0.0483 |
| **200** | 0.5324 | 0.4831 | 0.4413 | 0.4055 | 0.3017 | 0.2358 | 0.1907 | 0.1581 | 0.1335 | 0.1145 | 0.0995 | 0.0873 | 0.0773 | 0.0690 | 0.0620 | 0.0560 | 0.0509 |

# Thermal overload
## ANSI code 49 RMS
## Setting examples

### Hot curves

| I/Ib<br>Es (%) | 4.80 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 | 8.50 | 9.00 | 9.50 | 10.00 | 12.50 | 15.00 | 17.50 | 20.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **105** | 0.0023 | 0.0021 | 0.0017 | 0.0014 | 0.0012 | 0.0010 | 0.0009 | 0.0008 | 0.0007 | 0.0006 | 0.0006 | 0.0005 | 0.0003 | 0.0002 | 0.0002 | 0.0001 |
| **110** | 0.0045 | 0.0042 | 0.0034 | 0.0029 | 0.0024 | 0.0021 | 0.0018 | 0.0016 | 0.0014 | 0.0013 | 0.0011 | 0.0010 | 0.0006 | 0.0004 | 0.0003 | 0.0003 |
| **115** | 0.0068 | 0.0063 | 0.0051 | 0.0043 | 0.0036 | 0.0031 | 0.0027 | 0.0024 | 0.0021 | 0.0019 | 0.0017 | 0.0015 | 0.0010 | 0.0007 | 0.0005 | 0.0004 |
| **120** | 0.0091 | 0.0084 | 0.0069 | 0.0057 | 0.0049 | 0.0042 | 0.0036 | 0.0032 | 0.0028 | 0.0025 | 0.0022 | 0.0020 | 0.0013 | 0.0009 | 0.0007 | 0.0005 |
| **125** | 0.0114 | 0.0105 | 0.0086 | 0.0072 | 0.0061 | 0.0052 | 0.0045 | 0.0040 | 0.0035 | 0.0031 | 0.0028 | 0.0025 | 0.0016 | 0.0011 | 0.0008 | 0.0006 |
| **130** | 0.0137 | 0.0126 | 0.0103 | 0.0086 | 0.0073 | 0.0063 | 0.0054 | 0.0048 | 0.0042 | 0.0038 | 0.0034 | 0.0030 | 0.0019 | 0.0013 | 0.0010 | 0.0008 |
| **135** | 0.0160 | 0.0147 | 0.0120 | 0.0101 | 0.0085 | 0.0073 | 0.0064 | 0.0056 | 0.0049 | 0.0044 | 0.0039 | 0.0035 | 0.0023 | 0.0016 | 0.0011 | 0.0009 |
| **140** | 0.0183 | 0.0168 | 0.0138 | 0.0115 | 0.0097 | 0.0084 | 0.0073 | 0.0064 | 0.0056 | 0.0050 | 0.0045 | 0.0040 | 0.0026 | 0.0018 | 0.0013 | 0.0010 |
| **145** | 0.0206 | 0.0189 | 0.0155 | 0.0129 | 0.0110 | 0.0094 | 0.0082 | 0.0072 | 0.0063 | 0.0056 | 0.0051 | 0.0046 | 0.0029 | 0.0020 | 0.0015 | 0.0011 |
| **150** | 0.0229 | 0.0211 | 0.0172 | 0.0144 | 0.0122 | 0.0105 | 0.0091 | 0.0080 | 0.0070 | 0.0063 | 0.0056 | 0.0051 | 0.0032 | 0.0022 | 0.0016 | 0.0013 |
| **155** | 0.0253 | 0.0232 | 0.0190 | 0.0158 | 0.0134 | 0.0115 | 0.0100 | 0.0088 | 0.0077 | 0.0069 | 0.0062 | 0.0056 | 0.0035 | 0.0025 | 0.0018 | 0.0014 |
| **160** | 0.0276 | 0.0253 | 0.0207 | 0.0173 | 0.0147 | 0.0126 | 0.0109 | 0.0096 | 0.0085 | 0.0075 | 0.0067 | 0.0061 | 0.0039 | 0.0027 | 0.0020 | 0.0015 |
| **165** | 0.0299 | 0.0275 | 0.0225 | 0.0187 | 0.0159 | 0.0136 | 0.0118 | 0.0104 | 0.0092 | 0.0082 | 0.0073 | 0.0066 | 0.0042 | 0.0029 | 0.0021 | 0.0016 |
| **170** | 0.0323 | 0.0296 | 0.0242 | 0.0202 | 0.0171 | 0.0147 | 0.0128 | 0.0112 | 0.0099 | 0.0088 | 0.0079 | 0.0071 | 0.0045 | 0.0031 | 0.0023 | 0.0018 |
| **175** | 0.0346 | 0.0317 | 0.0260 | 0.0217 | 0.0183 | 0.0157 | 0.0137 | 0.0120 | 0.0106 | 0.0094 | 0.0084 | 0.0076 | 0.0048 | 0.0034 | 0.0025 | 0.0019 |
| **180** | 0.0370 | 0.0339 | 0.0277 | 0.0231 | 0.0196 | 0.0168 | 0.0146 | 0.0128 | 0.0113 | 0.0101 | 0.0090 | 0.0081 | 0.0052 | 0.0036 | 0.0026 | 0.0020 |
| **185** | 0.0393 | 0.0361 | 0.0295 | 0.0246 | 0.0208 | 0.0179 | 0.0155 | 0.0136 | 0.0120 | 0.0107 | 0.0096 | 0.0086 | 0.0055 | 0.0038 | 0.0028 | 0.0021 |
| **190** | 0.0417 | 0.0382 | 0.0313 | 0.0261 | 0.0221 | 0.0189 | 0.0164 | 0.0144 | 0.0127 | 0.0113 | 0.0101 | 0.0091 | 0.0058 | 0.0040 | 0.0030 | 0.0023 |
| **195** | 0.0441 | 0.0404 | 0.0330 | 0.0275 | 0.0233 | 0.0200 | 0.0173 | 0.0152 | 0.0134 | 0.0119 | 0.0107 | 0.0096 | 0.0061 | 0.0043 | 0.0031 | 0.0024 |
| **200** | 0.0464 | 0.0426 | 0.0348 | 0.0290 | 0.0245 | 0.0211 | 0.0183 | 0.0160 | 0.0141 | 0.0126 | 0.0113 | 0.0102 | 0.0065 | 0.0045 | 0.0033 | 0.0025 |

# Phase overcurrent
ANSI code 50/51

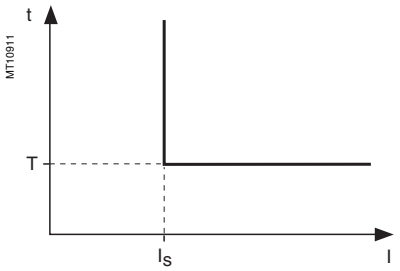
## Description
The phase overcurrent function comprises 2 groups of four units, called Group A and Group B respectively.
The mode of switching from one group to the other may be determined by parameter setting:
- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B) or by forcing the use of the group.

## Operation
Phase overcurrent protection is three-phase.
It picks up if one, two or three of the phase currents reach the operation set point.
The alarm connected to the operation of the protection function indicates the faulty phase or phases.
It includes a time delay, which is either definite (constant, **DT**) or IDMT depending on the curves on the facing page.

**Confirmation**
The phase overcurrent protection function includes a configurable confirmation component.
The output is confirmed as follows:
- by phase-to-phase undervoltage protection unit 1
- by negative sequence overvoltage protection
- no confirmation.

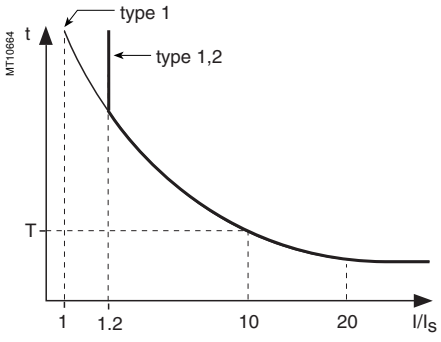
The protection incorporates a harmonic 2 restraint set point which can be used to set the protection Is set point close to the CT rated current, including when a transformer switches.
The restraint can be selected by parameter setting.
This harmonic 2 restraint is active when the current is less than half the minimum short-circuit current of the network downstream of the protection.

**Definite time protection functions**
Is is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

**IDMT protection**
IDMT protection operates in accordance with the IEC 60255-3, BS 142, IEEE C-37112 standards.




*IDMT protection principle.*

The Is setting corresponds to the vertical asymptote of the curve, and T is the operation time delay for 10 Is.
The tripping time for I/Is values less than 1.2 depends on the type of curve chosen.

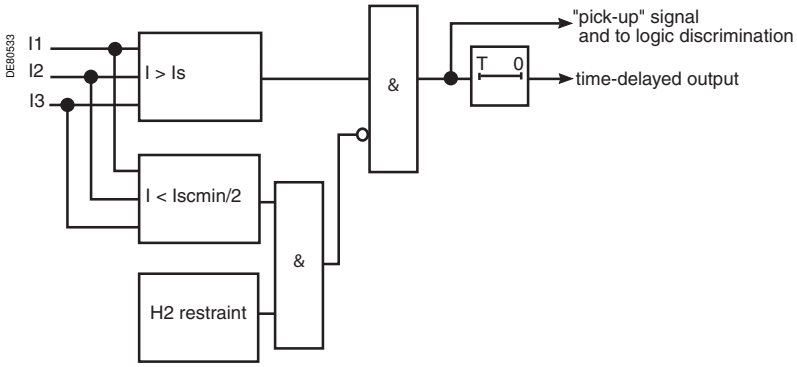
| Curve description | Type |
|---|---|
| Standard inverse time (SIT) | 1.2 |
| Very inverse time (VIT or LTI) | 1.2 |
| Extremely inverse time (EIT) | 1.2 |
| Ultra inverse time (UIT) | 1.2 |
| RI curve | 1 |
| IEC standard inverse time SIT/A | 1 |
| IEC very inverse time VIT or LTI/B | 1 |
| IEC extremely inverse time EIT/C | 1 |
| IEEE moderately inverse (IEC/D) | 1 |
| IEEE very inverse (IEC/E) | 1 |
| IEEE extremely inverse (IEC/F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

*The curve equations are given in the chapter entitled "IDMT protection functions".*

The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is, tripping time is the time that corresponds to 20 Is
- if I > 40 In, tripping time is the time that corresponds to 40 In

(In: rated current transformer current defined when entering the general settings).

## Block diagram

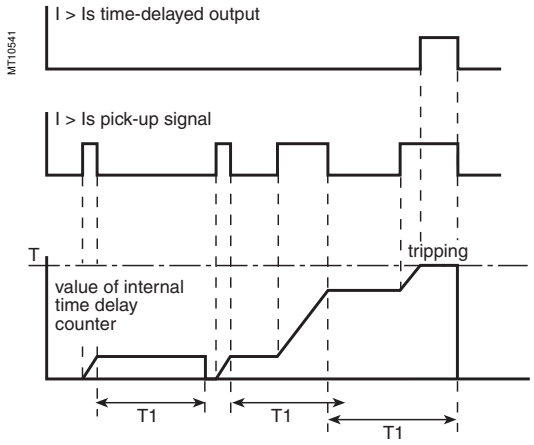


# Phase overcurrent
ANSI code 50/51

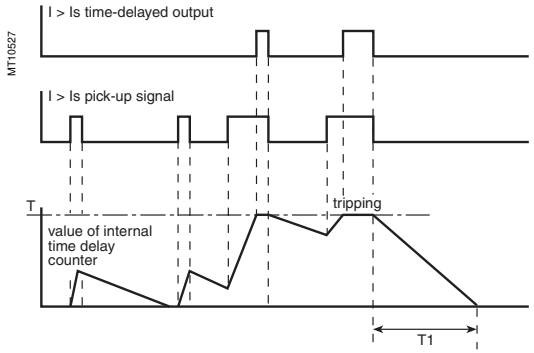
## Timer hold delay

The function includes an adjustable timer hold delay T1:

■ definite time (timer hold) for all the tripping curves




■ IDMT for IEC, IEEE and IAC curves




## Characteristics

| | | |
|---|---|---|
| **Tripping curve** | | |
| Setting | | Definite time,<br>IDMT: chosen according to list on page 72 |
| **Confirmation** | | |
| Setting | | by undervoltage (unit 1)<br>by negative sequence overvoltage<br>none, by confirmation |
| **Is set point** | | |
| Setting | Definite time | 0.1 In ⩽ Is ⩽ 24 In expressed in Amps |
| | IDMT | 0.1 In ⩽ Is ⩽ 2.4 In expressed in Amps |
| Resolution | | 1 A or 1 digit |
| Accuracy (1) | | ±5 % or ±0.01 In |
| Drop out/pick-up ratio | | 93.5 % ±5 % or > (1 - 0.015 In/Is) x 100 % |
| **Time delay T (operation time at 10 Is)** | | |
| Setting | Definite time | inst., 50 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 12.5 s or TMS (2) |
| Resolution | | 10 ms or 1 digit |
| Accuracy (1) | Definite time | ±2 % or from -10 ms to +25 ms |
| | IDMT | Class 5 or from -10 ms to +25 ms |
| **Timer hold delay T1** | | |
| Definite time (timer hold) | | 0; 0.05 to 300 s |
| IDMT (3) | | 0.5 to 20 s |
| **Characteristic times** | | |
| Operation time | | Pick-up < 35 ms at 2 Is (typically 25 ms) |
| | | Confirmed instantaneous:<br>■ inst. < 50 ms at 2 Is for Is ⩾ 0.3 In (typically 35 ms)<br>■ inst. < 70 ms at 2 Is for Is < 0.3 In (typically 50 ms) |
| Overshoot time | | < 35 ms |
| Reset time | | < 50 ms (for T1 = 0) |
| **Harmonic restraint 2** | | |
| Set point | | 5 to 50% |
| **Minimum short-circuit current Isc** | | |
| Setting | | In to 999 kA |

***1)*** *In reference conditions (IEC 60255-6).*

***(2)*** *Setting ranges in TMS (Time Multiplier Setting) mode*

| | |
|---|---|
| *Inverse (SIT) and IEC SIT/A:* | *0.04 to 4.20* |
| *Very inverse (VIT) and IEC VIT/B:* | *0.07 to 8.33* |
| *Very inverse (LTI) and IEC LTI/B:* | *0.01 to 0.93* |
| *Ext inverse (EIT) and IEC EIT/C:* | *0.13 to 15.47* |
| *IEEE moderately inverse:* | *0.42 to 51.86* |
| *IEEE very inverse:* | *0.73 to 90.57* |
| *IEEE extremely inverse:* | *1.24 to 154.32* |
| *IAC inverse:* | *0.34 to 42.08* |
| *IAC very inverse:* | *0.61 to 75.75* |
| *IAC extremely inverse:* | *1.08 to 134.4* |

***(3)*** *Only for standardized tripping curves of the IEC, IEEE and IAC types.*

## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC3 | BO08 | 20, 160, 23 | LLN0.SGCB.SetActiveSettingGroup |
| TC4 | BO09 | 20, 160, 24 | LLN0.SGCB.SetActiveSettingGroup |

# Phase overcurrent Cold Load Pick-Up/Blocking
CLPU 50/51



## Description

The Cold Load Pick-Up I or CLPU 50/51 function avoids nuisance tripping of the phase overcurrent protection (ANSI 50/51), during energization after a long outage. Depending on the installation characteristics, these operations can actually generate transient inrush currents likely to exceed the protection set points. These transient currents may be due to:

- the power transformer magnetizing currents
- the motor starting currents
- simultaneous resetting of all the loads in the installation (air conditioning, heating, etc.).

In principle, the protection settings should be defined so as to avoid tripping due to these transient currents. However, if these settings result in inadequate sensitivity levels or delays that are too long, the CLPU 50/51 function can be used to increase or inhibit set points temporarily after energization.

## Operation

The CLPU 50/51 function starts if one of the following three conditions is fulfilled:

- a phase current is detected after all the currents have disappeared for longer than the time before activation Tcold
- a logic input (I24 by default) has been activated, indicating a temporary overload due to starting of the load corresponding to the protected feeder, or a feeder downstream
- the start command for the CLPU 50/51 function has been activated from the logic equation editor.

This detection results in either, depending on the parameter setting of Global action CLPU 50/51, for a predefined duration:

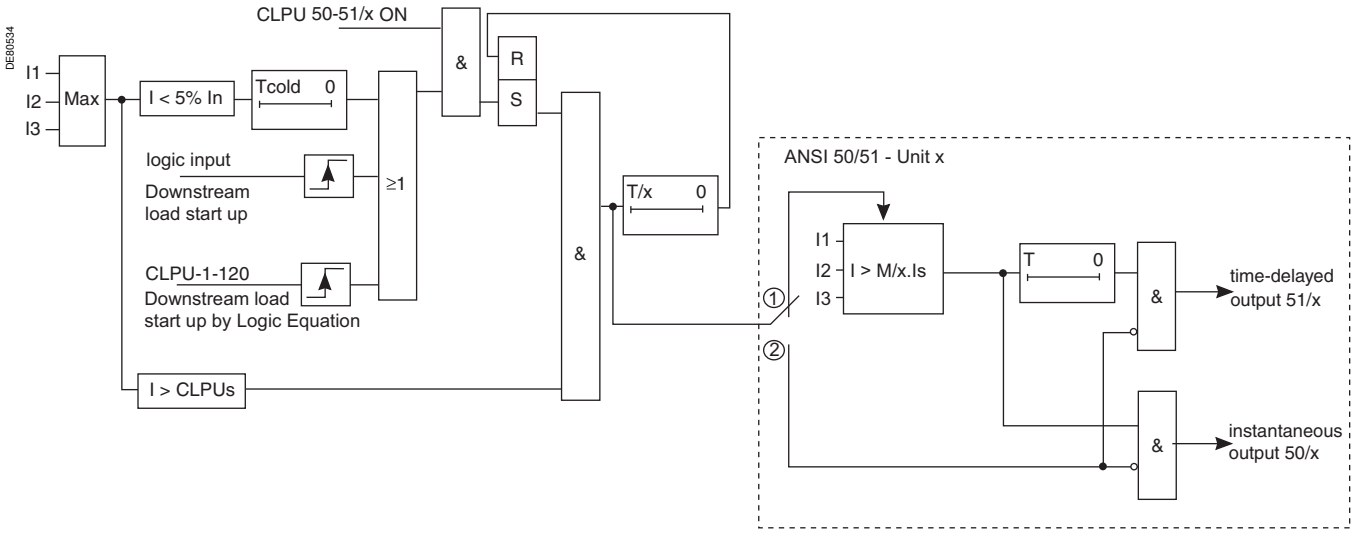
- application of a configurable multiplying factor to set point Is of each ANSI 50/51 protection unit
- or blocking of the various protection units.

Setting the CLPU 50/51 function parameters allows the user to:

- define the time before activation Tcold and the pick-up threshold CLPUs
- choose which ANSI 50/51 protection units it affects
- define the type of action (multiplying factor or blocking), its duration T/x and if necessary, the multiplying factor M/x for each ANSI 50/51 protection unit x

By default the CLPU 50/51 function is off.

## Block diagram




Action of the CLPU 50/51 function on set point Is of ANSI 50/51 protection unit x during time delay T/x depends on the Global action CLPU 50/51 setting:

① multiplication of set point Is by a coefficient M/x

② blocking

# Phase overcurrent Cold Load Pick-Up/Blocking
CLPU 50/51

## Characteristics

| | |
|---|---|
| **Time before activation Tcold (Setting common to CLPU 50/51 and CLPU 50N/51N functions)** | |
| Setting | 0.1 to 300 s |
| Resolution | 10 ms |
| Accuracy | ±2% or ±20 ms |
| **Pick-up threshold CLPUs (Setting common to CLPU 50/51 and CLPU 50N/51N functions)** | |
| Setting | 10 to 100% In |
| Resolution | 1% In |
| Accuracy | ±5% or ±1% In |
| **Global action CLPU 50/51** | |
| Setting | Blocking/Multiplication of the set point |
| **Action on ANSI 50/51 protection unit x** | |
| Setting | OFF/ON |
| **Time delay T/x for ANSI 50/51 protection unit x** | |
| Resolution setting | 100 to 999 ms in 1 ms steps |
| | 1 to 999 s in 1 s steps |
| | 1 to 999 min in 1 min steps |
| Accuracy | ±2% or ±20 ms |
| **Multiplying factor M/x for ANSI 50/51 protection unit x** | |
| Setting | 100 to 999% Is |
| Resolution | 1% Is |

# Breaker failure
ANSI code 50BF



## Operation

This function is designed to detect the failure of breakers that do not open when a tripping order is sent.

The "breaker failure" protection function is activated by an O1 output tripping order received from the overcurrent protection functions (50/51, 50N/51N, 46, 67N, 67). It checks for the disappearance of current during the time interval specified by the time delay T. It may also take into account the position of the circuit breaker read on the logic inputs to determine the actual opening of the breaker. Wiring a volt-free closed circuit breaker position contact on the "breaker closed" equation editor input can ensure that the protection is effective in the following situations:

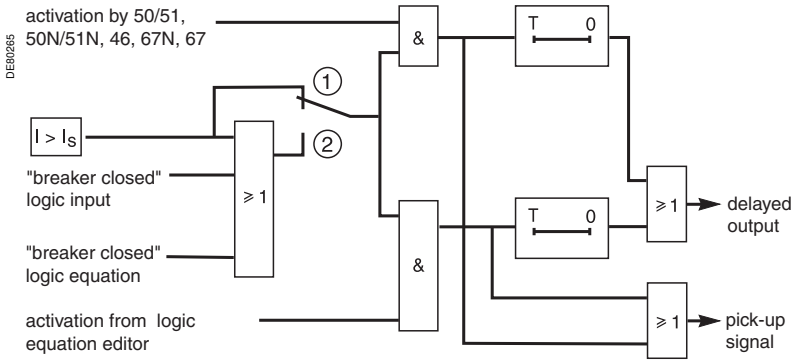
- When 50BF is activated by protection function 50N/51N (set point Is0 < 0.2 In), detection of the 50BF current set point can possibly be not operational.
- When trip circuit supervision (TCS) is used, the closed circuit breaker contact is short-circuited. Logic input I102 is therefore no longer operational.

Automatic activation of this protection function requires the use of the program logic circuit breaker control function. A specific input may also be used to activate the protection from the equation editor. That option is useful for adding special cases of activation (e.g. tripping by an external protection unit).

The time-delayed output of the protection unit should be assigned to a logic output via the control matrix.

The starting and stopping of the time delay T counter are conditioned by the presence of a current above the set point (I > Is).

## Block diagram



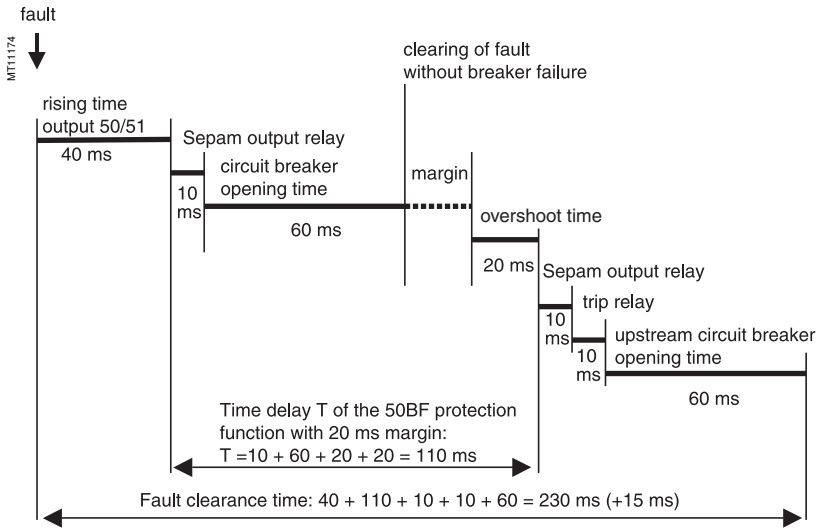

Setting: (1) Accounting for the circuit breaker position
(2) Not accounting for the circuit breaker

# Breaker failure
ANSI code 50BF



## Example of setting

The example below shows how to determine the time delay setting for the 50BF function
Overcurrent protection setting: T = inst.
Circuit breaker operating time: 60 ms.
Auxiliary relay operating time to open the upstream breaker or breakers: 10 ms.




The time delay for the 50BF function is the sum of the following times:
Sepam O1 output relay pick-up time = 10 ms
Circuit breaker opening time = 60 ms
Overshoot time for the breaker failure function = 20 ms
To avoid unwanted tripping of the upstream breakers, choose a margin of approximately 20 ms.
This gives us a time delay T = 110 ms.

## Characteristic

| | |
|---|---|
| **Is set point** | |
| Setting | 0.2 In to 2 In |
| Accuracy (1) | ±5 % |
| Resolution | 0.1 A |
| Drop out/pick-up ratio | (87.5 ±10) % |
| **Time delay T** | |
| Setting | 0,05 s to 300 s |
| Accuracy (1) | ±2 %, or from 0 ms to 15 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic time** | |
| Overshoot time | < 20 ms |
| **Taking into account of circuit breaker position** | |
| Setting | With / without |

***(1)*** *In reference conditions (IEC 60255-6)*

# Earth fault
## ANSI code 50N/51N or 50G/51G



### Description

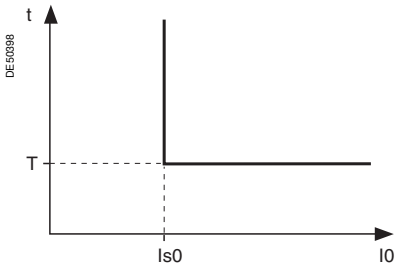
The earth fault protection function comprises 2 groups of four units, called Group A and Group B respectively. The mode of switching from one group to the other may be determined by parameter setting:
- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B) or by forcing the use of the group.

### Operation

Earth fault protection is single-phase.
It picks up if the earth fault current reaches the operation set point.
It includes a time delay, which is either definite (constant, **DT**) or IDMT depending on the curves on the facing page.
The protection function includes a harmonic 2 restraint which can be used to bypass the incorrect residual current on the sum of the 3 phase CTs when the transformers are energized.
The restraint can be selected by parameter setting.
The principle of this harmonic 2 restraint allows this protection to trip on intermittent earth faults.

**Definite time protection**

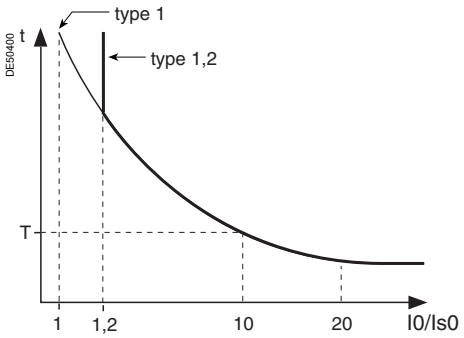
Is0 is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

**IDMT protection**

IDMT protection operates in accordance with the IEC 60255-3, BS 142 and IEEE C-37112 standards.




*IDMT protection principle.*

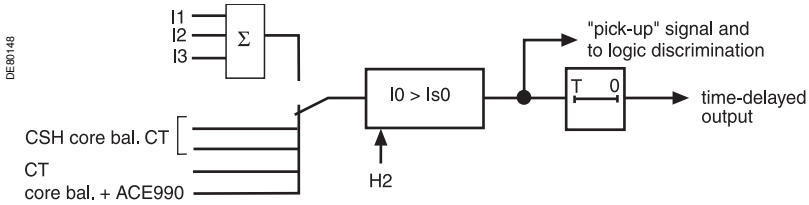
The Is0 setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is0.
The tripping time for I0/Is0 values of less than 1.2 depends on the type of curve chosen.

| Name of curve | Type |
|---|---|
| Standard inverse time (SIT) | 1.2 |
| Very inverse time (VIT or LTI) | 1.2 |
| Extremely inverse time (EIT) | 1.2 |
| Ultra inverse time (UIT) | 1.2 |
| RI curve | 1 |
| IEC standard inverse time SIT / A | 1 |
| IEC very inverse time VIT or LTI / B | 1 |
| IEC extremely inverse time EIT / C | 1 |
| IEEE moderately inverse (IEC / D) | 1 |
| IEEE very inverse (IEC / E) | 1 |
| IEEE extremely inverse (IEC / F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

*The curve equations are given in the chapter entitled "IDMT protection functions".*

The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is0, tripping time is the time that corresponds to 20 Is0
- if I > 20 In0, tripping time is the time that corresponds to 20 In0 (operation based on I0 input)
- if I0 > 40 In0, tripping time is the time that corresponds to 40 In0 (operation based on sum of phase currents).

### Block diagram



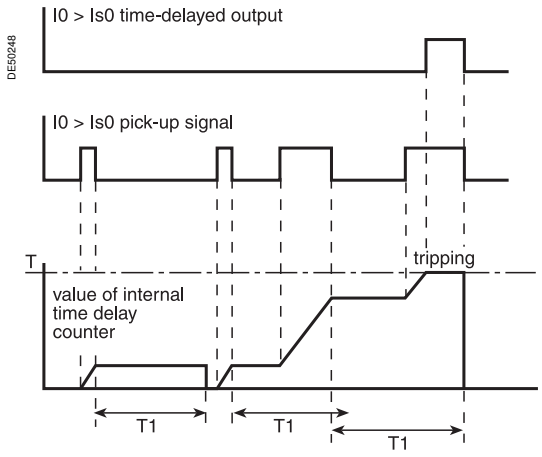

The choice between I0 (measured) and I0Σ (calculated by the sum of the phase currents) may be set for each unit, by default units 1 and 2 set to I0 and units 2 and 4 to I0Σ.
By mixing the 2 possibilities on the different units, it is possible to have:
- different dynamic set points
- different applications, e.g. zero sequence and tank earth leakage protection.

# Earth fault
## ANSI code 50N/51N or 50G/51G

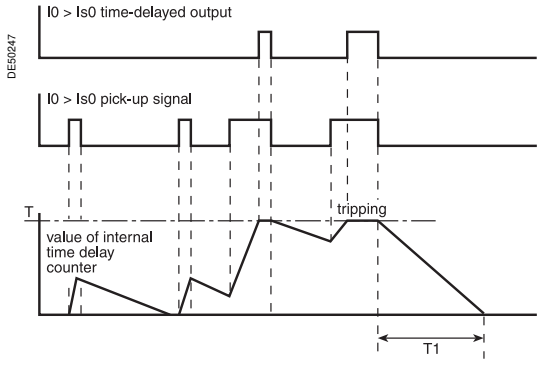
### Timer hold delay

The function includes an adjustable timer hold delay T1:

■ definite time (timer hold) for all the tripping curves




■ DMT for IEC, IEEE and IAC curves.




### Characteristics

| | | |
|---|---|---|
| **Tripping curve** | | |
| Setting | | Definite time,<br>IDMT: chosen according to list page 78 |
| **Is0 set point** | | |
| Definite time setting | | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (1) expressed in Amps |
| | Sum of CTs (5) | 0.1 In0 ⩽ Is0 ⩽ 15 In0 |
| | With CSH sensor | |
| | 2 A rating | 0.2 A to 30 A |
| | 5 A rating | 0.5 A to 75 A |
| | 20 A rating | 2 A to 300 A |
| | CT | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (min. 0.1 A) |
| | Core balance CT with ACE990 | 0.1 In0 < Is0 < 15 In0 |
| IDMT time setting | | 0.1 In0 ⩽ Is0 ⩽ In0 (1) expressed in Amps |
| | Sum of CTs (5) | 0.1 In0 ⩽ Is0 ⩽ In0 |
| | With CSH sensor | |
| | 2 A rating | 0.2 A to 2 A |
| | 5 A rating | 0.5 A to 5 A |
| | 20 A rating | 2 A to 20 A |
| | CT | 0.1 In0 ⩽ Is0 ⩽ In0 (min. 0.1 A) |
| | Core balance CT with ACE990 | 0.1 In0 < Is0 < In0 |
| Resolution | | 0.1 A or 1 digit |
| Accuracy (2) | | ±5 % or ±0.01 In0 |
| Drop out/pick-up ratio | | 93.5 % ±5 % (with CSH sensor, CT or core balance CT + ACE990) |
| | | 93.5 % ±5 % or > (1 - 0.015 In0/Is0) x 100 % (sum of CTs) |
| **Harmonic 2 restraint** | | |
| Fixed threshold | | 20 % ±5 % |
| **Time delay T (operation time at 10 Is0)** | | |
| Setting | Definite time | inst. 50 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 12.5 s or TMS (3) |
| Resolution | | 10 ms or 1 digit |
| Accuracy (2) | Definite time | ±2 % or from -10 ms to +25 ms |
| | IDMT | class 5 or from -10 ms to +25 ms |
| **Timer hold delay T1** | | |
| Definite time (timer hold) | | 0; 0.05 to 300 s |
| IDMT (4) | | 0.5 to 20 s |
| **Characteristic times** | | |
| Operation time | | Pick-up < 35 ms at 2 Is0 (typically 25 ms) |
| | | Confirmed instantaneous:<br>■ inst. < 50 ms at 2 Is0 for Is0 ⩾ 0.3 In0 (typically 35 ms)<br>■ inst. < 70 ms at 2 Is0 for Is0 < 0.3 In0 (typically 50 ms) |
| Overshoot time | | < 35 ms |
| Reset time | | < 40 ms (for T1 = 0) |

### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC3 | BO08 | 20, 160, 23 | LLN0.SGCB.SetActiveSettingGroup |
| TC4 | BO09 | 20, 160, 24 | LLN0.SGCB.SetActiveSettingGroup |

*(1) In0 = In if the sum of the three phase currents is used for the measurement.*
*In0 = sensor rating if the measurement is taken by a CSH core balance CT.*
*In0 = In of the CT at In/10 according to parameter setting if the measurement is taken by a 1 A or 5 A current transformer.*
*(2) In reference conditions (IEC 60255-6)*
*(3) Setting ranges in TMS (Time Multiplier Setting) mode*
*Inverse (SIT) and IECIEC SIT/A: 0.04 to 4.20*
*Very inverse (VIT) and IEC VIT/B: 0.07 to 8.33*
*Very inverse (LTI) and IEC LTI/B:0.01 to 0.93*
*Ext inverse (EIT) and IEC EIT/C: 0.13 to 15.47*
*IEEE moderately inverse: 0.42 to 51.86*
*IEEE very inverse: 0.73 to 90.57*
*IEEE extremely inverse: 1.24 to 154.32*
*IAC inverse: 0.34 to 42.08*
*IAC very inverse: 0.61 to 75.75*
*IAC extremely inverse:1.08 to 134.4*
*(4) Only for standardized tripping curves of the IEC, IEEE and IAC types.*
*(5) For Is0 < 0.4 In0, the minimum time delay is 300 ms.*
*If a shorter time delay is needed, use the CT + CSH30 or CT + CCA634 combination.*

# Earth fault Cold Load Pick-Up/ Blocking
## CLPU 50N/51N



### Description

The Cold Load Pick-Up I0 or CLPU 50N/51N function avoids nuisance tripping of the earth fault protection (ANSI 50N/51N) during energization after a long outage.
Depending on the installation characteristics, such operations can actually generate transient inrush currents.
If the residual current measurement is based on the sum of the 3 phase CTs, the aperiodic component of these transient currents can result in saturation of the phase CTs, which can result in a residual current measurement likely to exceed the protection set points.
These transient currents are essentially due to:
- the power transformer magnetizing currents
- the motor starting current.

In principle, the protection settings should be defined so as to avoid tripping due to these transient currents. However, if these settings result in inadequate sensitivity levels or delays that are too long, the CLPU 50N/51N function is used to increase or inhibit set points temporarily after energization.
If the residual current is measured by a correctly installed CT, there is less risk of measuring an incorrect residual current. In this case, there is no need to use the CLPU 50N/51N function.

### Operation

The CLPU 50N/51N function starts if one of the following three conditions is fulfilled:
- a phase current is detected after all the currents have disappeared for longer than the time before activation Tcold
- a logic input (I24 by default) has been activated, indicating a temporary overload due to starting of the load corresponding to the protected feeder, or a feeder downstream
- the start command for the CLPU 50N/51N function has been activated from the logic equation editor.

This detection results in either, depending on the parameter setting of Global action CLPU 50N/51N, for a predefined duration:
- application of a configurable multiplying factor to set point Is0 of each ANSI 50N/51N protection unit
- or blocking of the various protection units

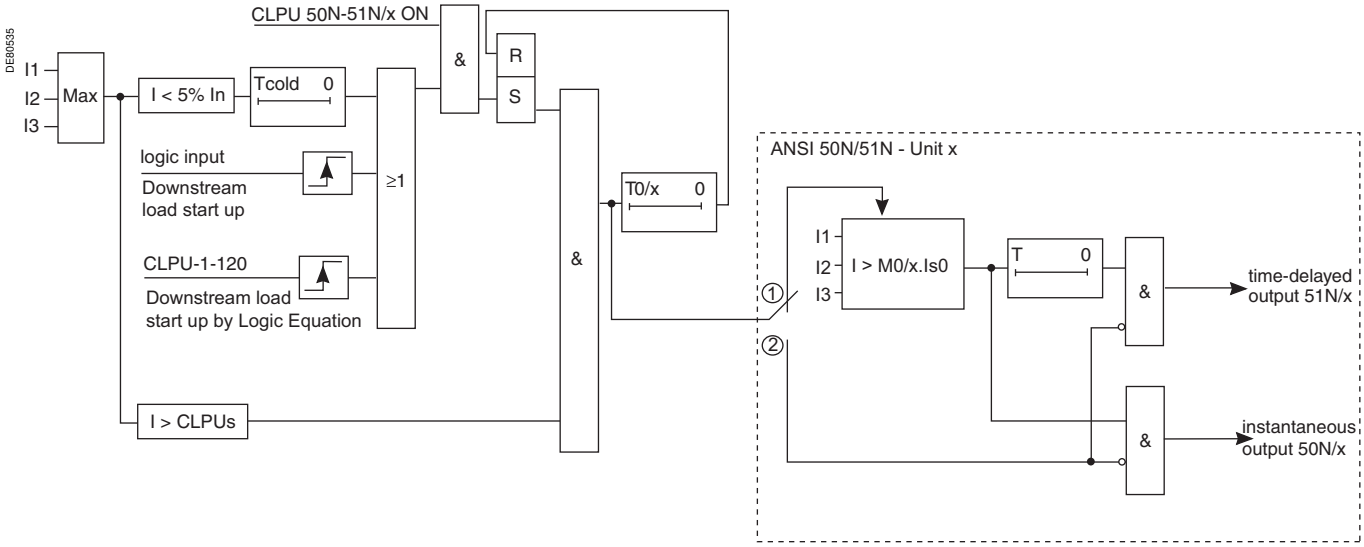
Setting the CLPU 50N/51N function parameters consists of:
- defining the time before activation Tcold and the pick-up threshold CLPUs
- choosing which ANSI 50N/51N protection units it affects
- defining the type of action (multiplying factor or blocking), its duration T0/x and if necessary, the multiplying factor M0/x for each ANSI 50N/51N protection unit x.

By default the CLPU 50N/51N function is off.

### Setting assistance

During use with multiplying factor M0/x, it is advisable to set the Is0 set point of the 50N/51N protection unit higher than the pick-up threshold CLPUs.

### Block diagram




Action of the CLPU 50N/51N function on set point Is0 of ANSI 50N/51N protection unit x during time delay T0/x depends on the Global action CLPU 50N/51N setting:
① multiplication of set point Is0 by a coefficient M0/x
② blocking

# Earth fault Cold Load Pick-Up/ Blocking
CLPU 50N/51N

## Characteristics

| | |
|---|---|
| **Time before activation Tcold (Setting common to CLPU 50/51 and CLPU 50N/51N functions)** | |
| Setting | 0.1 to 300 s |
| Resolution | 10 ms |
| Accuracy | ±2% or ±20 ms |
| **Pick-up threshold CLPUs (Setting common to CLPU 50/51 and CLPU 50N/51N functions)** | |
| Setting | 10 to 100% In |
| Resolution | 1% In |
| Accuracy | ±5% or ±1% In |
| **Global action CLPU 50N/51N** | |
| Setting | Blocking/Multiplication of the set point |
| **Action on ANSI 50N/51N protection unit x** | |
| Setting | OFF/ON |
| **Time delay T0/x for ANSI 50N/51N protection unit x** | |
| Resolution setting | 100 to 999 ms in 1 ms steps |
| | 1 to 999 s in 1 s steps |
| | 1 to 999 min in 1 min steps |
| Accuracy | ±2% or ±20 ms |
| **Multiplying factor M0/x for ANSI 50N/51N protection unit x** | |
| Setting | 100 to 999% Is0 |
| Resolution | 1% Is |

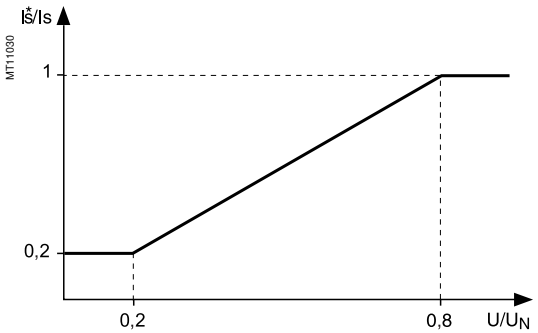
# Voltage-restrained phase overcurrent
## ANSI code 50V/51V



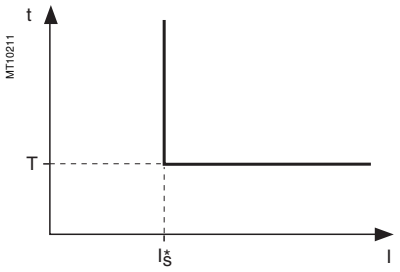
### Operation

The voltage-restrained phase overcurrent protection function is used to protect generators. The operation set point is adjusted according to the voltage to take into account cases of faults close to the generator which cause voltage dips and short-circuit current.
This protection function is three-pole. It picks up if one, two or three phase currents reach the voltage-adjusted operation set point Is*.
The alarm linked to operation indicates the faulty phase or phases.
It is time-delayed, and the time delay may be definite time (DT) or IDMT according to the curves opposite.
The set point is adjusted according to the lowest of the phase-to-phase voltages measured.
The adjusted set point Is* is defined by the following equation:

$$I_s^* = \frac{I_s}{3} x \left(4\frac{U}{U_N} - 0.2\right)$$

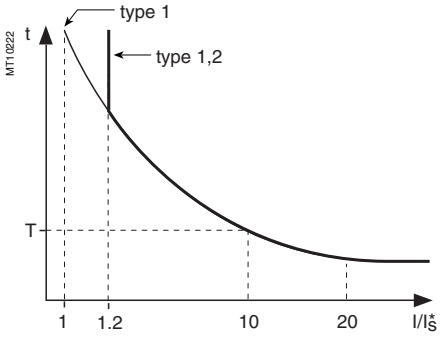



**Definite time protection**
Is is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

**IDMT protection**
IDMT protection operates in accordance with the IEC 60255-3, BS 142 and IEEE C-37112 standards.




*IDMT protection principle.*

The Is0 setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is0.
The tripping time for I0/Is0 values of less than 1.2 depends on the type of curve chosen.

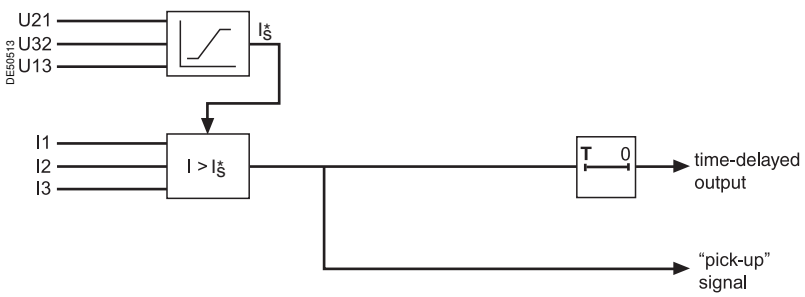
| Name of curve | Type |
|---|---|
| Standard inverse time (SIT) | 1.2 |
| Very inverse time (VIT or LTI) | 1.2 |
| Extremely inverse time (EIT) | 1.2 |
| Ultra inverse time (UIT) | 1.2 |
| RI curve | 1 |
| IEC standard inverse time SIT / A | 1 |
| IEC very inverse time VIT or LTI / B | 1 |
| IEC extremely inverse time EIT / C | 1 |
| IEEE moderately inverse (IEC / D) | 1 |
| IEEE very inverse (IEC / E) | 1 |
| IEEE extremely inverse (IEC / F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

*The curve equations are given in the chapter entitled "IDMT protection functions".*

The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is, tripping time is the time that corresponds to 20 Is
- if I > 40 In, tripping time is the time that corresponds to 40 In

(In: current transformer rated current defined when the general settings are made).

### Block diagram

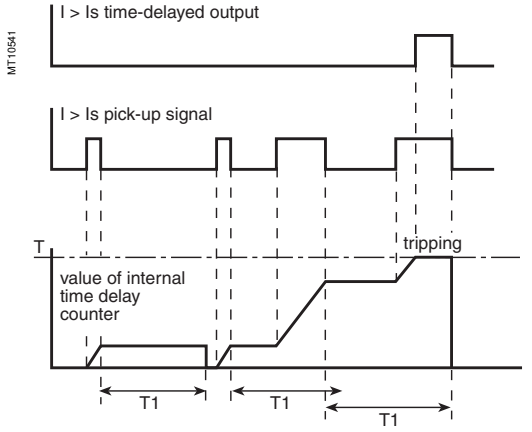


# Voltage-restrained phase overcurrent
ANSI code 50V/51V

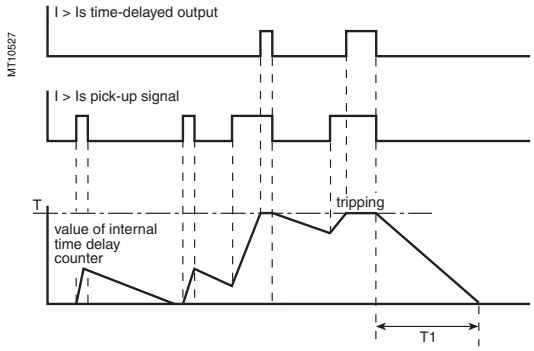
## Timer hold delay

The function includes an adjustable timer hold delay T1:

■ definite time (timer hold) for all the tripping curves




■ IDMT for IEC, IEEE and IAC curves




## Characteristics

| | | |
|---|---|---|
| **Tripping curve** | | |
| Setting | | Definite time,<br>IDMT: chosen according to list page 82 |
| **Is set point** | | |
| Setting | Definite time | 0.5 In ⩽ Is ⩽ 24 In expressed in Amps |
| | IDMT | 0.5 In ⩽ Is ⩽ 2.4 In expressed in Amps |
| Resolution | | 1 A or 1 digit |
| Accuracy (1) | | ±5 % or ±0.01 In |
| Drop out/pick-up ratio | | 93.5 % ±5 % or > (1 - 0.015 In/Is*) x 100 % |
| **Time delay T (operation time at 10 Is0)** | | |
| Setting | Definite time | inst. 50 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 12.5 s or TMS (2) |
| Resolution | | 10 ms or 1 digit |
| Accuracy (1) | Definite time | ±2 % or from -10 ms to +25 ms |
| | IDMT | class 5 or from -10 ms to +25 ms |
| **Timer hold delay T1** | | |
| Definite time (timer hold) | | 0; 0.05 to 300 s |
| IDMT (3) | | 0.5 to 20 s |
| **Characteristic times** | | |
| Operation time | | pick-up < 35 ms at 2 Is (typically 25 ms)<br>Confirmed instantaneous:<br>■ inst. < 50 ms at 2 Is* for Is* > 0.3 In (typically 35 ms)<br>■ inst. < 70 ms at 2 Is* for Is* ⩽ 0.3 In (typically 50 ms) |
| Overshoot time | | < 35 ms |
| Reset time | | < 50 ms (for T1 = 0) |

***(1)*** *In reference conditions (IEC 60255-6)*

***(2)*** *Setting ranges in TMS (Time Multiplier Setting) mode*

*Inverse (SIT) and IECIEC SIT/A: 0.04 to 4.20*
*Very inverse (VIT) and IEC VIT/B: 0.07 to 8.33*
*Very inverse (LTI) and IEC LTI/B: 0.01 to 0.93*
*Ext inverse (EIT) and IEC EIT/C: 0.13 to 15.47*
*IEEE moderately inverse: 0.42 to 51.86*
*IEEE very inverse: 0.73 to 90.57*
*IEEE extremely inverse: 1.24 to 154.32*
*IAC inverse: 0.34 to 42.08*
*IAC very inverse: 0.61 to 75.75*
*IAC extremely inverse: 1.08 to 134.4*

***(3)*** *Only for standardized tripping curves of the IEC, IEEE and IAC types.*

# Overvoltage
ANSI code 59

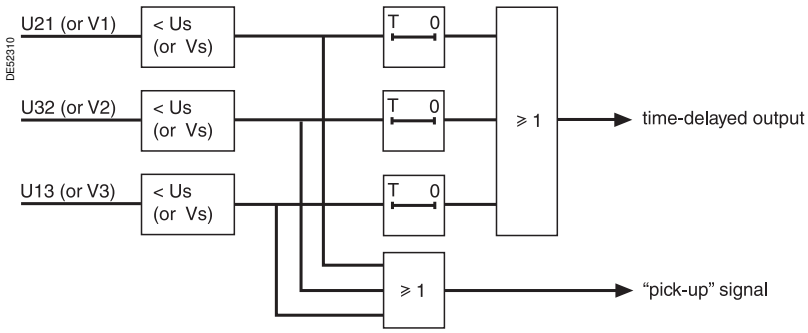


## Operation

The protection function is single-phase and operates with phase-to-neutral or phase-to-phase voltage:

- it picks up if one of the voltages concerned is above the Us (or Vs) set point
- it includes a definite time delay T
- with phase-to-neutral operation, it indicates the faulty phase in the alarm associated with the fault.

## Block diagram




## Characteristics

| | |
|---|---|
| **Us (or Vs) set point** | |
| Setting | 50 to 150% Unp (or Vnp) if Uns < 208 V |
| | 50 to 135% Unp (or Vnp) if Uns ⩾ 208 V |
| Accuracy (1) | ±2 % or ±0.005 Unp |
| Resolution | 1 % |
| Drop out/pick up ratio | 97 % ±1 % |
| **Time delay T** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | pick-up < 35 ms (typically 25 ms) |
| Overshoot time | < 35 ms |
| Reset time | < 40 ms |

***(1)*** *In reference conditions (IEC 60255-6).*

| **Connnection conditions** | | | | | |
|---|---|---|---|---|---|
| Type of connection | V1, V2, V3 | U21 | U21, U32 | U21 + V0 | U21, U32 + V0 |
| Phase-to-neutral operation | Yes | No | No | No | Yes |
| Phase-to-phase operation | Yes | on U21 only | Yes | on U21 only | Yes |

# Neutral voltage displacement
ANSI code 59N

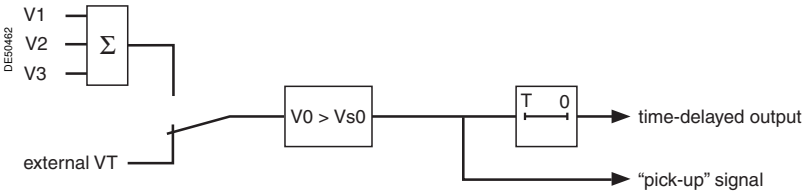
## Operation

The protection function picks up if the residual voltage V0 is above a Vs0 set point,

with $\vec{V0} = \vec{V1} + \vec{V2} + \vec{V3}$ ,

- it includes a definite time delay T.
- the residual voltage is either calculated from the 3 phase voltages or measured by an external VT
- the protection function operates for connections: V1V2V3, U21U32 + V0 and U21 + V0.

## Block diagram




## Characteristics

| | |
|---|---|
| **Vs0 set point** | |
| Setting | 2 % Unp to 80 % Unp if Vnso (2) = sum of 3Vs |
| | 2 % Unp to 80 % Unp if Vnso (2) = Uns / $\sqrt{3}$ |
| | 5 % Unp to 80 % Unp if Vnso (2) = Uns / 3 |
| Accuracy (1) | ±2 % or ±0.002 Unp |
| Resolution | 1 % |
| Drop out/pick up ratio | 97 % ±1 % or > (1 - 0.001 Unp/Vs0) x 100 % |
| **Temporisation T** | |
| Setting | 50 ms to 300 s |
| Accuracy (1) | ±2 %, or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times** | |
| Operation time | pick-up < 35 ms |
| Overshoot time | < 35 ms |
| Reset time | < 40 ms |

***(1)*** *In reference conditions (IEC 60255-6).*
***(2)*** *Vnso is one of the general settings.*

# Starts per hour
ANSI code 66



## Operation

This function is three-phase.
It picks up when the number of starts reaches the following limits:
- maximum number of starts (Nt) allowed per period of time (P)
- maximum allowed number of consecutive hot starts (Nh)
- maximum allowed number of consecutive cold starts (Nc).

Starting is detected when the current consumed becomes greater than 10 % of the Ib current.

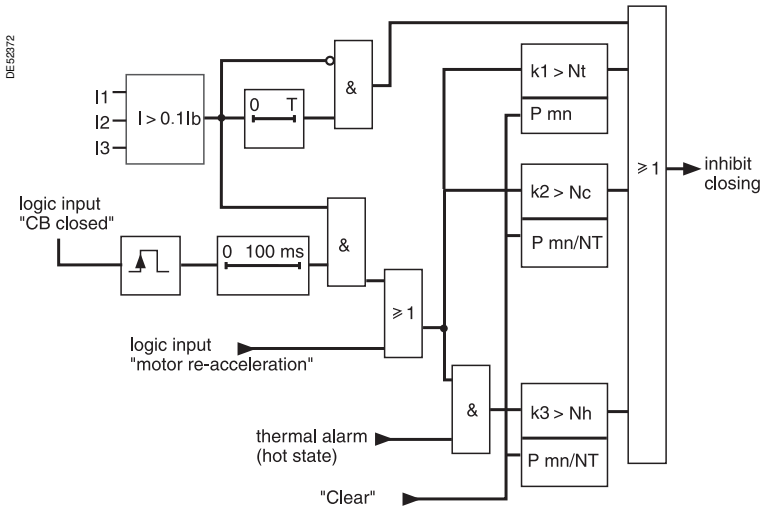
The number of consecutive starts is the number starts counted during the last P/Nt minutes, Nt being the number of starts allowed per period.
The motor hot state corresponds to the overshooting of the fixed set point (50 % heat rise) of the thermal overload function.
When the motor re-accelerates, it undergoes a stress similar to that of starting without the current first passing through a value less than 10 % of Ib, in which case the number of starts is not incremented.
It is possible however to increment the number of starts when a re-acceleration occurs by a logic data input (logic input "motor re-acceleration").
The "stop/start" time delay T may be used to inhibit starting after a stop until the delay has elapsed.

**Use of circuit breaker closed data**
In synchronous motor applications, it is advisable to connect the "circuit breaker closed" data to a logic input in order to enable more precise detection of starts. If the "circuit breaker closed" data is not connected to a logic input, the detection of a start is not conditioned by the position of the circuit breaker.

**User information**
The following information is available for the user:
- the waiting time before a start is allowed
- the number of starts still allowed.

See chapter "Machine operation assistance functions", page 37.

## Block diagram




## Characteristics

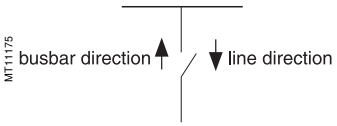
| | |
|---|---|
| **Period of time (P)** | |
| Setting | 1 to 6 hr |
| Resolution | 1 |
| **Nt total number of starts** | |
| Setting | 1 to 60 |
| Resolution | 1 |
| **Nh and Nc number of consecutive starts** | |
| Setting (1) | 1 to Nt |
| Resolution | 1 |
| **T time delay stop/start** | |
| Setting | 0 mn ⩽ T ⩽ 90 mn (0: no time delay) |
| Resolution | 1 mn or 1 digit |

***(1)*** *With Nh ⩽ Nc.*

# Directional phase overcurrent
ANSI code 67

## Description
The directional phase overcurrent function includes 2 groups of 2 units called respectively Group A and Group B.
The mode for switching from one group to the other may be determined by parameter setting:
- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B) or by forcing the use of the group.

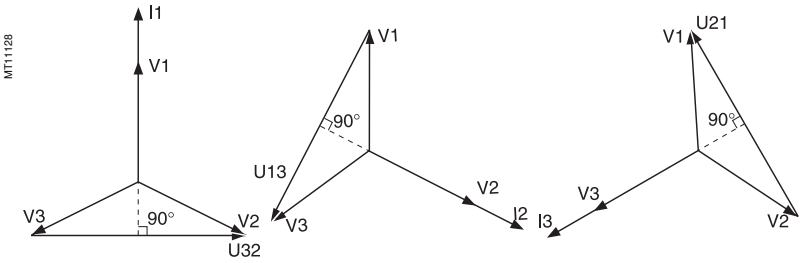
## Operation
This protection function is three-phase. It includes a phase overcurrent function associated with direction detection. It picks up if the phase overcurrent function in the chosen direction (line or busbar) is activated for at least one of the three phases (or two out of three phases, according to parameter setting). The alarm linked to the protection operation indicates the faulty phase or phases.
It is time-delayed and the time delay may be definite time (**DT**) or IDMT according to the curves page 89.
The direction of the current is determined according to the measurement of the phase in relation to a polarization value. It is qualified as busbar direction or line direction according to the following convention:



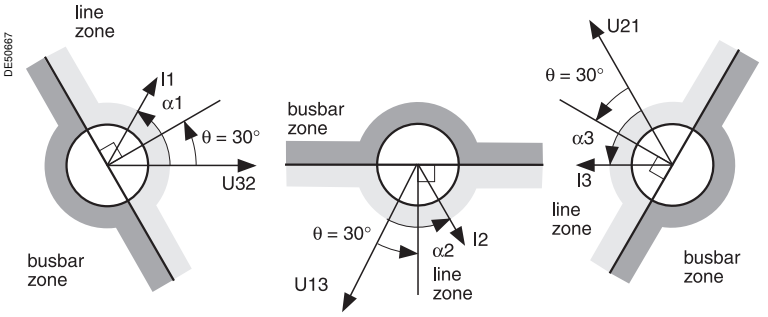

The polarization value is the phase-to-phase value in quadrature with the current for cosφ= 1 (90° connection angle).
A phase current vector plane is divided into two half-planes that correspond to the line zone and busbar zone. The characteristic angle θ is the angle of the perpendicular to the boundary line between the 2 zones and the polarization value.

## Voltage memory
Should all the voltages disappear during a 3-phase fault near the busbar, the voltage level may be insufficient
for the fault direction to be detected (< 1.5 % Unp). The protection function therefore uses a voltage memory to reliably determine the direction. The fault direction is saved as long as the voltage level is too low and the current is above the Is set point.

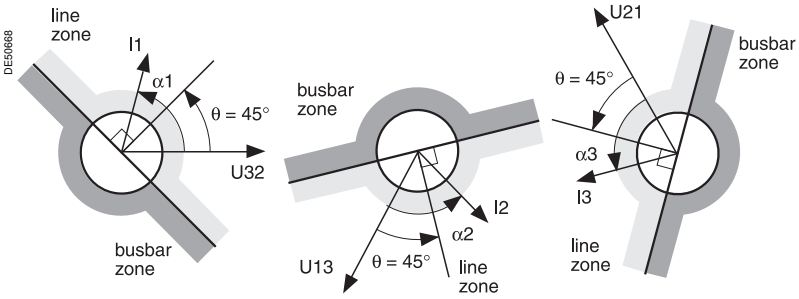
**Closing due to a pre-existing fault**
If the circuit breaker is closed due to a pre-existing 3-phase fault on the busbar, the voltage memory is blank. As a result, the direction cannot be determined and the protection does not trip. In such cases, a backup 50/51 protection function should be used.



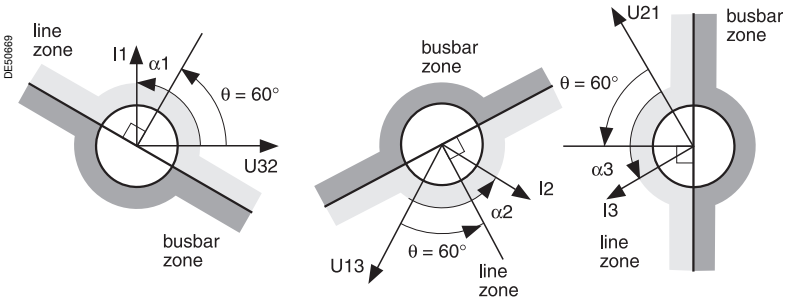

*Three-phase function: polarization currents and voltages.*




*Fault tripping in line zone with θ = 30°.*




*Fault tripping in line zone with θ = 45°.*

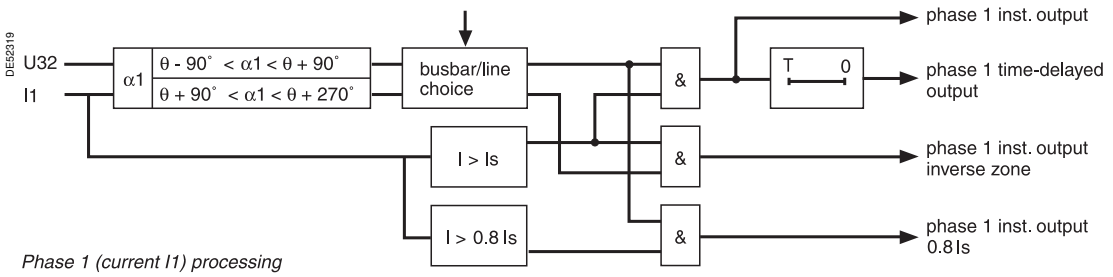



*Fault tripping in line zone with θ = 60°.*

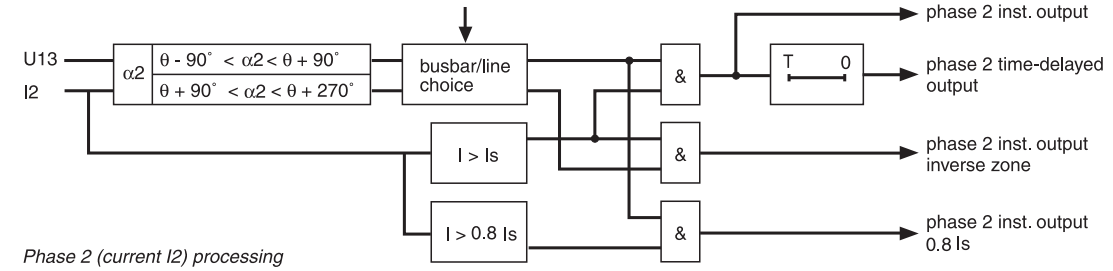
# Directional phase overcurrent
ANSI code 67



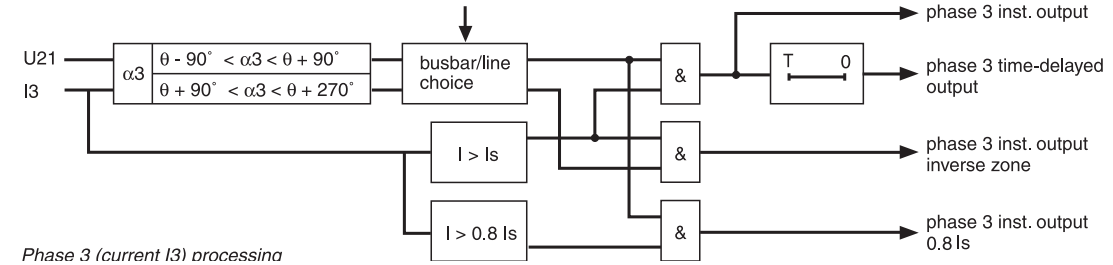
## Block diagram



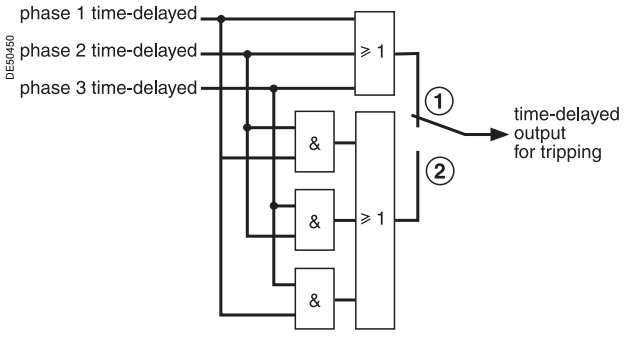

*Phase 1 (current I1) processing*

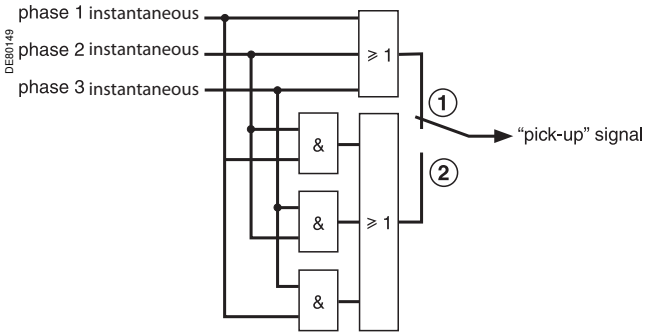


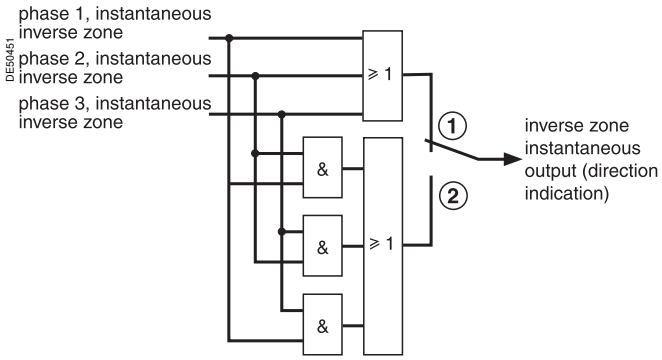

*Phase 2 (current I2) processing*



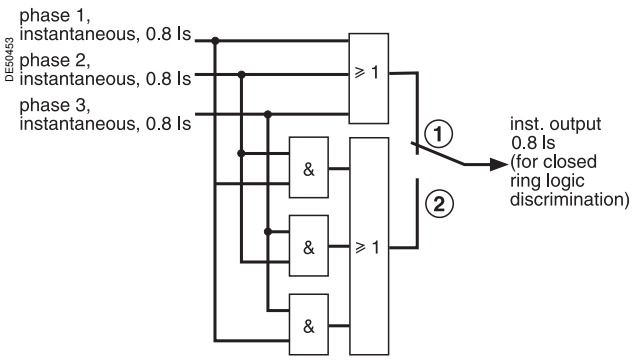

*Phase 3 (current I3) processing*




*Grouping of output data*




*Setting of tripping logic:*

1 *one out of three*

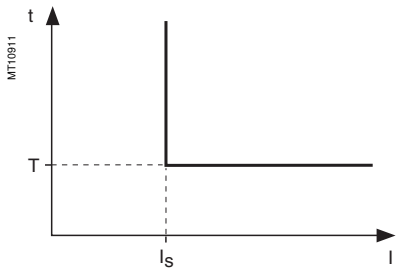
2 *two out of three*

*Grouping of output data*

# Directional phase overcurrent
ANSI code 67

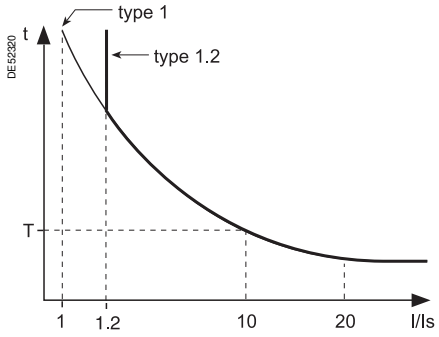
## Tripping logic
In certain cases, it is wise to choose a tripping logic of the two out of three phases type. Such cases may occur when two parallel transformers (Dy) are being protected. For a 2-phase fault on a transformer primary winding, there is a 2-1-1 ratio current distribution at the secondary end. The highest current is in the expected zone (operation zone for the faulty incomer, no operation zone for the fault-free incomer).
One of the lowest currents is at the limit of the zone. According to the line parameters, it may even be in the wrong zone.
There is therefore a risk of tripping both incomers.

## Time delay
**Definite time protection**
Is is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

**IDMT protection**
IDMT protection operates in accordance with the IEC 60255-3, BS 142 and IEEE C-37112 standards.




*IDMT protection principle.*

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is.
The tripping time for I/Is values of less than 1.2 depends on the type of curve chosen.

| Name of curve | Type |
|---|---|
| Standard inverse time (SIT) | 1.2 |
| Very inverse time (VIT or LTI) | 1.2 |
| Extremely inverse time (EIT) | 1.2 |
| Ultra inverse time (UIT) | 1.2 |
| RI curve | 1 |
| IEC standard inverse time SIT / A | 1 |
| IEC very inverse time VIT or LTI / B | 1 |
| IEC extremely inverse time EIT / C | 1 |
| IEEE moderately inverse (IEC / D) | 1 |
| IEEE very inverse (IEC / E) | 1 |
| IEEE extremely inverse (IEC / F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

*The curve equations are given in the chapter entitled "IDMT protection functions".*

The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is, tripping time is the time that corresponds to 20 Is
- if I > 40 In, tripping time is the time that corresponds to 40 In.

(In: current transformer rated current defined when the general settings are made).

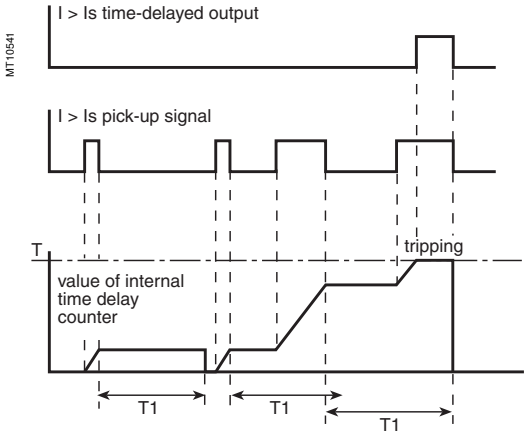
# Directional phase overcurrent
ANSI code 67



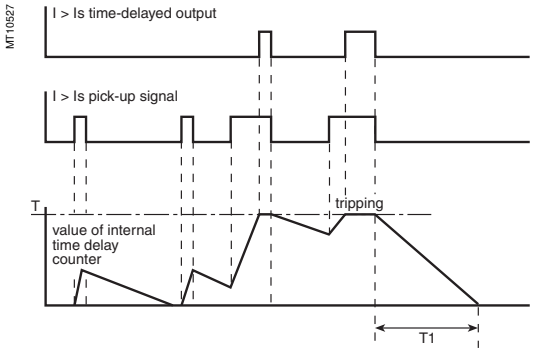
## Timer hold delay

The function includes an adjustable timer hold delay T1:

■ definite time (timer hold) for all the tripping curves




■ IDMT for IEC, IEEE and IAC curves




## Characteristics

| | | |
|---|---|---|
| **Characteristic angle θ** | | |
| Setting | | 30°, 45°, 60° |
| Accuracy | | ±2° |
| **Tripping direction** | | |
| Setting | | Busbar / line |
| **Tripping logic** | | |
| Setting | | One out of three / two out of three |
| **Tripping curve** | | |
| Setting | | Definite time |
| | | IDMT: chosen according to list page 89 |
| **Is set point** | | |
| Setting | Definite time | 0.1 In ⩽ Is ⩽ 24 In expressed in Amps |
| | IDMT | 0.1 In ⩽ Is ⩽ 2.4 In expressed in Amps |
| Resolution | | 1 A or 1 digit |
| Accuracy (1) | | ±5 % or ±0.01 In |
| Drop out/pick-up ratio | | 93.5 % ±5 % or > (1 - 0.015 In/Is) x 100 % |
| **Time delay T (operation time at 10 Is)** | | |
| Setting | Definite time | inst., 50 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 12.5 s or TMS (2) |
| Resolution | | 10 ms or 1 digit |
| Accuracy (1) | Definite time | t ⩾ 100 ms<br>±2 % or from -10 ms to +25 ms |
| | IDMT | Class 5 or from -10 ms to +25 ms |
| **Timer hold delay T1** | | |
| Definite time | | |
| (timer hold) | | 0 ; 0.05 to 300 s |
| IDMT (3) | | 0.5 to 20 s |
| **Characteristic times** | | |
| Operation time | | pick-up < 75 ms to 2 Is (typically 65 ms) |
| | | inst < 90 ms to 2 Is (confirmed instantaneous) (typically 75 ms) |
| Overshoot time | | < 40 ms |
| Reset time | | < 50 ms (for T1 = 0) |

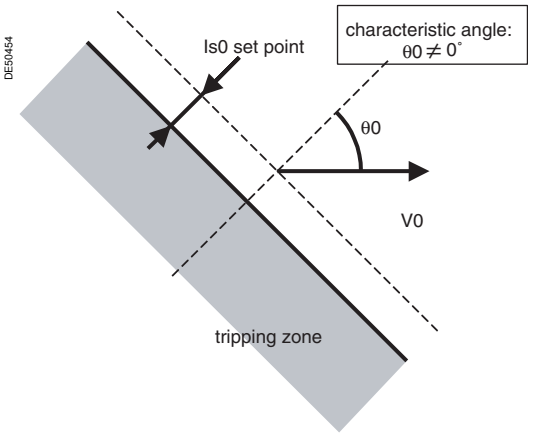
***(1)*** *In reference conditions (IEC 60255-6).*
***(2)*** *Setting ranges in TMS (Time Multiplier Setting) mode*
- *Inverse (SIT) and IEC SIT/A: 0.04 to 4.20*
- *Very inverse (VIT) and IEC VIT/B: 0.07 to 8.33*
- *Long time inverse (LTI) and IEC LTI/B: 0.01 to 0.93*
- *Extremely inverse (EIT) and IEC EIT/C: 0.13 to 15.47*
- *IEEE moderately inverse: 0.42 to 51.86*
- *IEEE very inverse: 0.73 to 90.57*
- *IEEE extremely inverse: 1.24 to 154.32*
- *IAC inverse: 0.34 to 42.08*
- *IAC very inverse: 0.61 to 75.75*
- *IAC extremely inverse: 1.08 to 134.4*

***(3)*** *Only for standardized tripping curves of the IEC, IEEE and IAC types.*

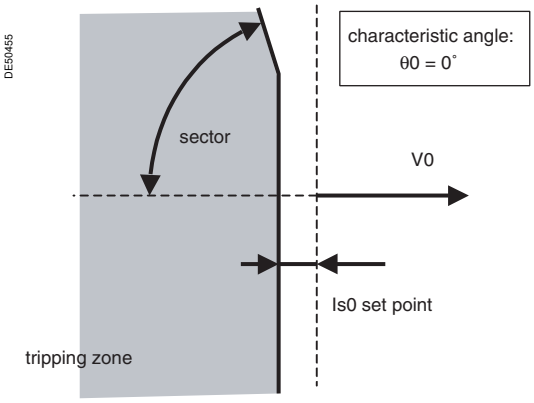
## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC3 | BO08 | 20, 160, 23 | LLN0.SGCB.SetActiveSettingGroup |
| TC4 | BO09 | 20, 160, 24 | LLN0.SGCB.SetActiveSettingGroup |

# Directional earth fault
ANSI code 67N/67NC




*Tripping characteristic of protection function 67N type 1 (θ0 ≠ 0°).*




*Tripping characteristic of protection function 67N type 1 (θ0 = 0°).*

## Description

This function comprises 2 groups of settings, with 2 units for each group.
The mode of switching groups of settings may be determined by parameter setting:
- by input I13 (I13 = 0 group A, I13 = 1 group B)
- by remote control (TC3, TC4)
- operation with a single group (group A or group B).

To adapt to all cases of applications and all earthing systems, the protection function operates according to two different types of characteristics, i.e. a choice of:
- type 1: the protection function uses I0 vector projection
- type 2: the protection function uses I0 vector magnitude
- type 3: the protection function uses I0 vector magnitude according to the Italian ENEL DK5600 specification.

## Type 1 operation

The function determines the projection of the residual current I0 on the characteristic line, the position of which is set by the setting of characteristic angle θ0 in relation to the residual voltage. The projection value is compared to the Is0 set point.
The projection method is suitable for radial feeders in resistive, isolated or compensated neutral systems.

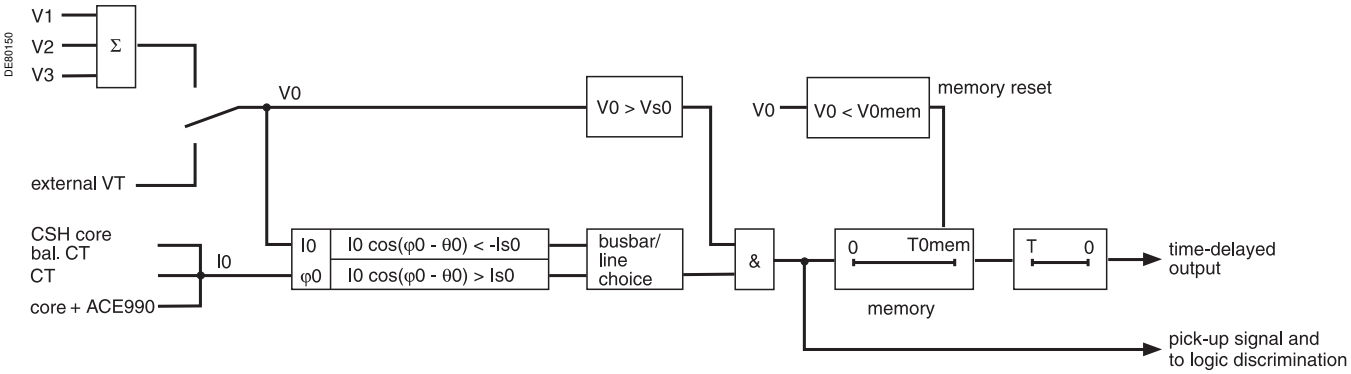
With compensated neutral systems, it is characterized by its capacity to detect very brief, repetitive faults (recurrent faults). In the case of Petersen coils with no additional resistance, fault detection in steady state operating conditions is not possible due to the absence of active zero sequence current. The protection function uses the transient current at the beginning of the fault to ensure tripping.

The θ0 = 0° setting is suitable for compensated neutral systems. When this setting is selected, the parameter setting of the sector is used to reduce the protection tripping zone to ensure its stability on fault-free feeders.

The protection function operates with the residual current measured at the relay I0 input (operation with sum of three currents impossible). The protection function is inhibited for residual voltages below the Vs0 set point. The time delay is definite time.

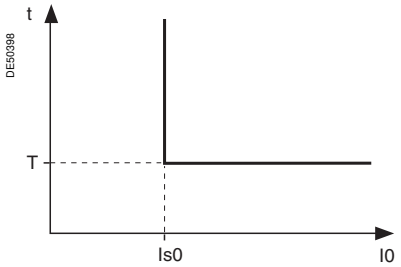
When a memory is added, recurrent faults can be detected; the memory is controlled by a time delay or by the residual voltage value.
The tripping direction can be set at the busbar end or line end.

## Block diagram



### Definite time operation

Is0 is the operation set point expressed in Amps, and T is the protection operation time delay.




*Definite time protection principle.*

### Memory

The detection of recurrent faults is controlled by the time delay T0mem which extends the transient pick-up information, thereby enabling the operation of the definite time delay even with faults that are rapidly extinguished (≈ 2 ms) and restrike periodically.
Even when a Petersen coil with no additional resistance is used, tripping is ensured by fault detection during the transient fault appearance, with detection extended throughout the duration of the fault based on the V0 ≥ V0mem criterion, within the limit of T0mem. With this type of application, T0mem must be greater than T (definite time delay).

#### Standard setting

The settings below are given for usual applications in the different earthing systems. The shaded boxes represent default settings.

| | **Isolated neutral** | **Impedant neutral** | **Compensated neutral** |
|---|---|---|---|
| Is0 set point | To be set according to network coordination study | To be set according to network coordination study | To be set according to network coordination study |
| Characteristic angle θ0 | 90° | 0° | 0° |
| Time delay T | To be set according to network coordination study | To be set according to network coordination study | To be set according to network coordination study |
| Direction | Line | Line | Line |
| Vs0 setpoint | 2 % of Uns | 2 % of Uns | 2 % of Uns |
| Sector | N/A | 86° | 86° |
| Memory time T0mem | 0 | 0 | 200 ms |
| Memory voltage V0mem | 0 | 0 | 0 |

# Directional earth fault
ANSI code 67N/67NC

## Characteristics - Type 1

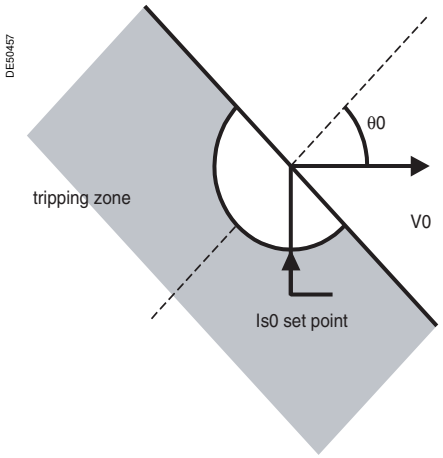
| | | |
|---|---|---|
| **Measurement origin** | | |
| Setting range | | I0 |
| **Characteristic angle θ0** | | |
| Setting | | -45°, 0°, 15°, 30°, 45°, 60°, 90° |
| Accuracy | | ±3° |
| **Tripping direction** | | |
| Setting | | Busbar / line |
| **Is0 set point** | | |
| Setting (1) | | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (1) expressed in Amps |
| | With CSH sensor | |
| | 2 A rating | 0.2 A ⩽ Is0 ⩽ 30 A |
| | 5 A rating | 0.5 A ⩽ Is0 ⩽ 75 A |
| | 20 A rating | 2 A ⩽ Is0 ⩽ 300 A |
| | CT (1) | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (min. 0.1 A) |
| | Core balance CT with ACE990 | 0.1 In0 ⩽ Is0 ⩽ 15 In0 |
| Resolution | | 0.1 A or 1 digit |
| Accuracy at φ0 = 180° + θ0 | | ±5 % or ±0.01 In0 |
| Drop out/pick-up ratio | | > 89 % or > (1 - 0.015 In0/Is0) x 100 % |
| **Vs0 set point** | | |
| Setting | | 2 % Unp to 80 % Unp |
| Resolution | | 1 % |
| Accuracy at φ0 = 180° + θ0 | | ±5 % |
| Drop out/pick-up ratio | | > 89 % |
| **Sector** | | |
| Setting | | 86°; 83°; 76° |
| Accuracy | With CCA634 | ± 2° |
| | With CT + CSH30 | ± 3° |
| **Time delay T** | | |
| Setting | | inst., 0.05 s ⩽ T ⩽ 300 s |
| Resolution | | 10 ms or 1 digit |
| Accuracy | | ⩽ 2 % or -10 ms to +25 ms |
| **Memory time T0mem** | | |
| Setting | | 0,05 s ⩽ T0mem ⩽ 300 s |
| Resolution | | 10 ms or 1 digit |
| **Memory voltage V0mem** | | |
| Setting | | 0; 2 % Unp ⩽ V0mem ⩽ 80 % Unp |
| Resolution | | 1 % |
| **Characteristic times** | | |
| Operation time | | Pick-up < 45 ms |
| | | Confirmed instantaneous:<br>■ inst. < 50 ms at 2 Is0 for Is0 ⩾ 0.3 In0 (typically 35 ms)<br>■ inst. < 70 ms at 2 Is0 for Is0 < 0.3 In0 (typically 50 ms) |
| Overshoot time | | < 35 ms |
| Reset time | | < 35 ms (at T0mem = 0) |

***(1)*** *In0 = sensor rating if the measurement is taken by a CSH120 or CSH200 core balance CT.*
*In0 = In of the CT if the measurement is taken by a 1 A or 5 A current transformer.*
*In0 = In of the CT /10 if the measurement is taken by a 1 A or 5 A current transformer with the sensitivity x 10 option.*

## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC3 | BO08 | 20, 160, 23 | LLN0.SGCB.SetActiveSettingGroup |
| TC4 | BO09 | 20, 160, 24 | LLN0.SGCB.SetActiveSettingGroup |

# Directional earth fault
ANSI code 67N/67NC



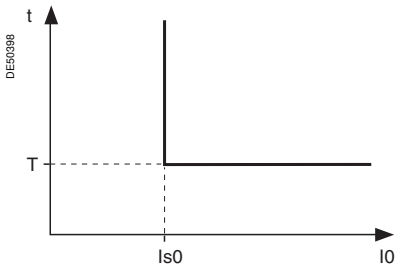

*Tripping characteristic of protection 67N, type 2.*

## Type 2 operation

The protection function operates like an earth fault protection function with an added direction criterion.
It is suitable for closed ring distribution networks with directly earthed neutral. It has all the characteristics of an earth fault protection function (50N/51N) and can therefore be easily coordinated with that function.
The residual current is the current measured at the Sepam I0 input or calculated using the sum of the phase currents, according to the parameter setting.
The time delay may be definite time (DT) or IDMT according to the curves below.
The protection function includes a timer hold delay T1 for the detection of restriking faults.
The tripping direction may be set at the busbar end or line end.

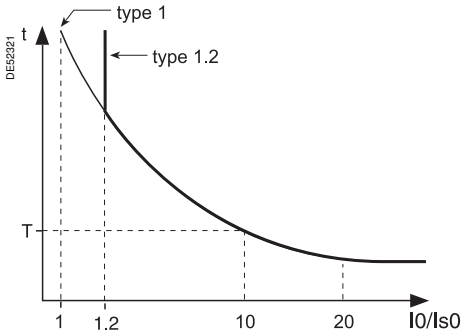
**Definite time protection**

Is0 is the operation set point expressed in Amps, and T is the protection operation time delay.




**IDMT protection**

The IDMT protection function operates in accordance with the IEC 60255-3, BS 142 and IEEE C-37112 standards.



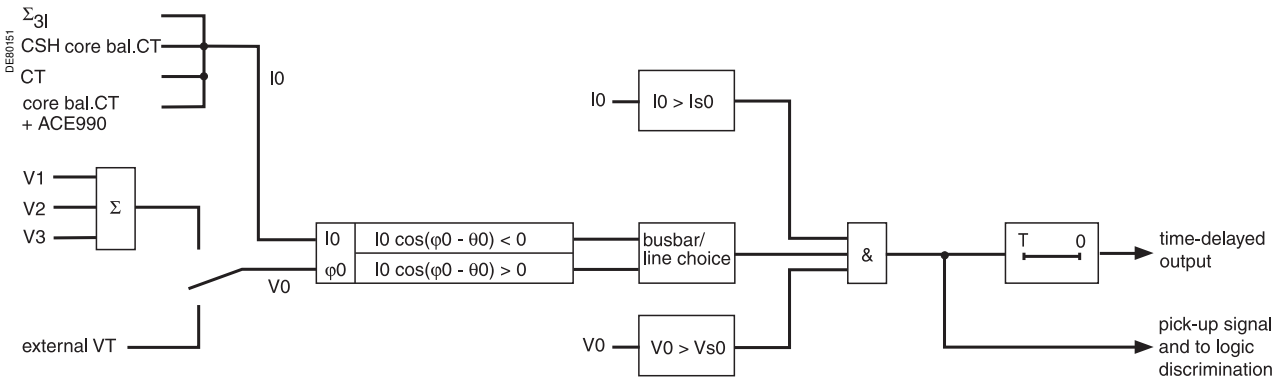

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is0.
The tripping time for I0/Is0 values of less than 1.2 depends on the type of curve chosen.

| Name of curve | Type |
|---|---|
| Standard inverse time (SIT) | 1.2 |
| Very inverse time (VIT or LTI) | 1.2 |
| Extremely inverse time (EIT) | 1.2 |
| Ultra inverse time (UIT) | 1.2 |
| RI curve | 1 |
| IEC temps inverse SIT / A | 1 |
| IEC very inverse time VIT or LTI / B | 1 |
| IEC extremely inverse time EIT / C | 1 |
| IEEE moderately inverse (IEC / D) | 1 |
| IEEE very inverse (IEC / E) | 1 |
| IEEE extremely inverse (IEC / F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

*The curve equations are given in the chapter entitled "IDMT protection functions".*

# Directional earth fault
ANSI code 67N/67NC

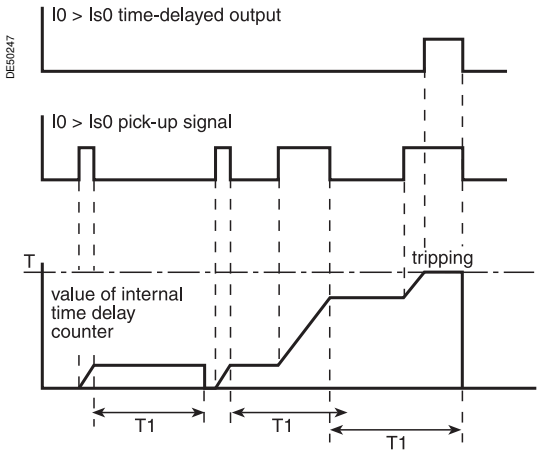
## Block diagram



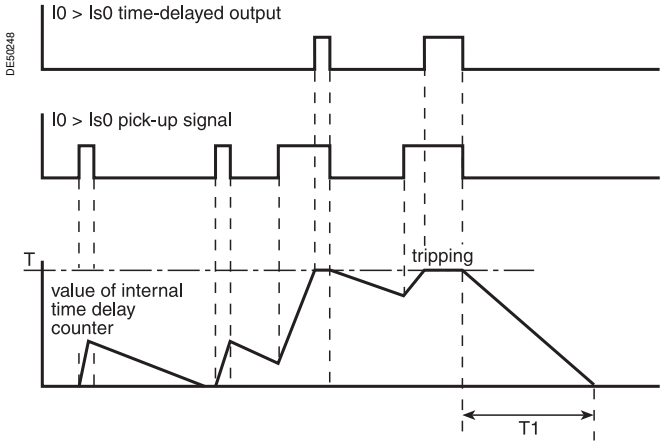

## Timer hold delay

The function includes an adjustable timer hold delay T1:

■ definite time (timer hold) for all the tripping curves.




■ IDMT for IEC, IEEE and IAC curves.



# Directional earth fault
ANSI code 67N/67NC

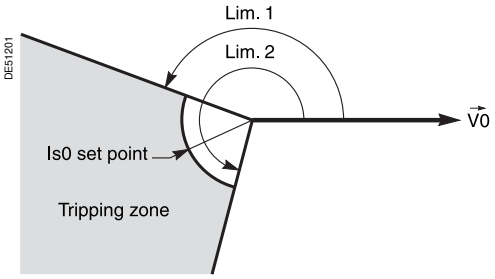


## Characteristics - Type 2

| | | |
|---|---|---|
| **Measurement origin** | | |
| Setting range | | I0 |
| | | I0Σ |
| **Characteristic angle θ0** | | |
| Setting | | -45°, 0°, 15°, 30°, 45°, 60°, 90° |
| Accuracy | | ±3° |
| **Tripping direction** | | |
| Setting | | Busbar / line |
| **Is0 setting** | | |
| Definite time setting | | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (1) expressed in Amps |
| | Sum of CTs | 0.1 In0 ⩽ Is0 ⩽ 15 In0 |
| | With CSH sensor | |
| | 2 A rating | 0.2 A to 30 A |
| | 5 A rating | 0.5 A to 75 A |
| | 20 A rating | 2 A to 300 A |
| | CT | 0.1 In0 ⩽ Is0 ⩽ 15 In0 (min. 0.1 A) |
| | Core balance CT with ACE990 | 0.1 In0 < Is0 < 15 In0 |
| IDMTsetting | | 0.1 In0 ⩽ Is0 ⩽ In0 (1) expessed in Amps |
| | Sum of CTs | 0.1 In0 ⩽ Is0 ⩽ In0 |
| | With CSH sensor | |
| | 2 A rating | 0.2 A to 2 A |
| | 5 A rating | 0.5 A to 5 A |
| | 20 A rating | 2 A to 20 A |
| | CT | 0.1 In0 ⩽ Is0 ⩽ 1 In0 (min. 0.1 A) |
| | Core balance CT with ACE990 | 0.1 In0 ⩽ Is0 ⩽ In0 |
| Resolution | | 0.1 A or 1 digit |
| Accuracy (2) | | ±5 % or ±0.01 In0 |
| Drop out/pick-up ratio | | 93.5 % ±5 %<br>(with CSH sensor, CT or core balance CT + ACE990) |
| | | 93.5 % ±5 %<br>or > (1 - 0.015 In0/Is0) x 100 %<br>(sum of CTs) |
| **Vs0 set point** | | |
| Setting | | 2 % Un to 80 % Un |
| Resolution | | 1 % |
| Accuracy | | ±5 % |
| Drop out/pick-up ratio | | 93.5 % ±5 % |
| **Time delay T (operation time at 10 Is0)** | | |
| Setting | definite time | inst., 50 ms ⩽ T ⩽ 300 s |
| | IDMT | 100 ms ⩽ T ⩽ 12.5 s or TMS (3) |
| Resolution | | 10 ms or 1 digit |
| Accuracy (2) | definite time | 2 % or -10 ms to +25 ms |
| | IDMT | Class 5 or from -10 to +25 ms |
| **Timer hold delay T1** | | |
| Definite time (timer hold) | | 0; 50 ms ⩽ T1 ⩽ 300 s |
| IDMT (4) | | 0.5 s ⩽ T1 ⩽ 20 s |
| **Characteristic times** | | |
| Operation time | | Pick-up < 40 ms at 2 Is0 (typically 25 ms) |
| | | Confirmed instantaneous:<br>■ inst. < 50 ms at 2 Is0 for Is0 ⩾ 0.3 In0 (typically 35 ms)<br>■ inst. < 70 ms at 2 Is0 for Is0 < 0.3 In0 (typically 50 ms) |
| Overshoot time | | < 35 ms |
| Reset time | | < 40 ms (for T1 = 0) |

***(1)*** *In0 = In if the sum of the three phase currents is used for the measurement.*
*In0 = sensor rating if the measurement is taken by a CSH120 or CSH200 core balance CT.*
*In0 = In of the CT if the measurement is taken by a 1 A or 5 A current transformer .*
*In0 = In of the CT /10 if the measurement is taken by a 1 A or 5 A current transformer with the sensitivity x 10 option.*
***(2)*** *In reference conditions (IEC 60255-6).*
***(3)*** *Setting ranges in TMS (Time Multiplier Setting) mode*
*Inverse (SIT) and IEC SIT/A: 0.04 to 4.20*
*Very inverse (VIT) and IEC VIT/B:0.07 to 8.33*
*Very inverse (LTI) and IEC LTI/B:0.01 to 0.93*
*Ext inverse (EIT) and IEC EIT/C: 0.13 to 15.47*
*IEEE moderately inverse:0.42 to 51.86*
*IEEE very inverse: 0.73 to 90.57*
*IEEE extremely inverse: 1.24 to 154.32*
*IAC inverse: 0.34 to 42.08*
*IAC very inverse: 0.61 to 75.75*
*IAC extremely inverse:1.08 to 134.4*
*(**4**) Only for standardized tripping curves of the IEC, IEEE and IAC types.*

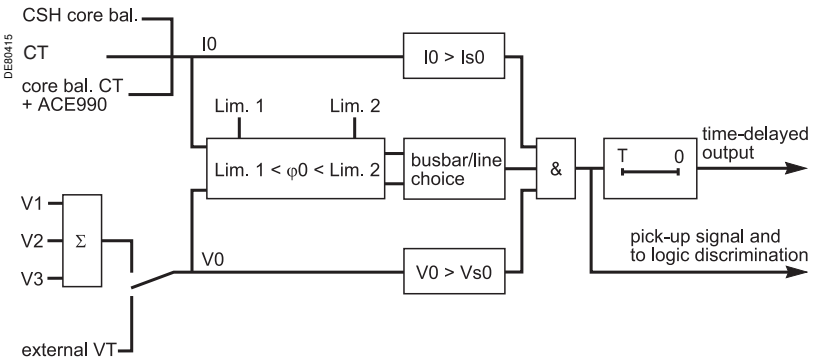
# Directional earth fault
ANSI code 67N/67NC




## Type 3 operation

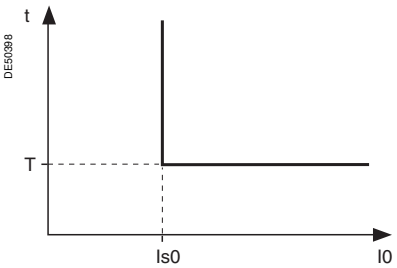
The protection function operates like an earth fault protection function with an added angular direction criterion {*Lim.1*, *Lim.2*}.
It is adapted for distribution networks in which the neutral earthing system varies according to the operating mode.
The tripping direction may be set at the busbar end or line end.
The residual current is the current measured at the Sepam I0 input.
The time delay may be definite time (DT).
In choosing an Is0 setting equal to zero, the protection is equivalent to the neutral voltage displacement protection (ANSI 59N).

## Block diagram




### Definite time operation

Is0 is the operation set point expressed in Amps, and T is the protection operation time delay




*Definite time protection principle.*

# Directional earth fault
ANSI code 67N/67NC



## Characteristics - Type 3

| | | |
|---|---|---|
| **Measurement origin** | | |
| Setting range | | I0 |
| **Angle at start of tripping zone *Lim.1*** | | |
| Setting | | 0° to 359° |
| Resolution | | 1° |
| Accuracy | | ±3° |
| **Angle at end of tripping zone *Lim.2*** | | |
| Setting | | 0° to 359° (1) |
| Resolution | | 1° |
| Accuracy | | ±3° |
| **Tripping direction** | | |
| Setting | | Busbar / line |
| **Is0 setting** | | |
| Setting (2) | With CSH core balance CT | 2 A rating: 0.1 A to 30 A |
| | | 20 A rating: 2 A to 300 A |
| | With sensitive 1 A CT | 0.05 In0 ⩽ Is0 ⩽ 15 In0 (minimum 0.1 A) |
| | With core balance CT + ACE990 (range 1) | 0.05 In0 ⩽ Is0 ⩽ 15 In0 (minimum 0.1 A) (3) |
| Resolution | | 0.1 A or 1 digit |
| Accuracy | | ±5 % |
| Drop out/pick-up ratio | | ⩾ 90 % |
| **Vs0 set point** | | |
| Setting | Calculated V0 (sum of 3 voltages) | 2 % Unp ⩽ Vs0 ⩽ 80 % Unp |
| | Measured V0 (external VT) | 0.6 % Unp ⩽ Vs0 ⩽ 80 % Unp |
| Resolution | | 0.1 % for Vs0 < 10 %<br>1 % for Vs0 ⩾ 10 % |
| Accuracy | | ±5 % |
| Drop out/pick-up ratio | | ⩾ 90 % |
| **Time delay T** | | |
| Setting | | Instantaneous, 50 ms ⩽ T ⩽ 300 s |
| Resolution | | 10 ms or 1 digit |
| Accuracy | | ⩽ 3 % or ±20 ms at 2 Is0 |
| **Characteristics times** | | |
| Operation time | | Pick-up < 40 ms at 2 Is0 |
| | | Instantaneous < 50 ms at 2 Is0 |
| Overshoot time | | < 35 ms to 2 Is0 |
| Reset time | | < 50 ms to 2 Is0 |

***(1)*** *The tripping zone Lim.2-Lim.1 must be greater than or equal to 10°.*
***(2)*** *For Is0 = 0, the protection is equivalent to the neutral voltage displacement protection (ANSI 59N).*
***(3)*** *In0 = k . n*
*with n = number of core balance CT turns*
*and k = factor to be determined according to the wiring of the ACE990 (0.00578 ⩽ k ⩽ 0.04).*

## Standard settings for tripping zone

The settings below are given for usual applications in the different earthing systems. The shaded boxes represent default settings.

| | Isolated neutral | Impedant neutral | Directly earthed neutral |
|---|---|---|---|
| Angle *Lim.1* | 190° | 100° | 100° |
| Angle *Lim.2* | 350° | 280° | 280° |

# Recloser
## ANSI code 79



## Definition

**Reclaim time**
The reclaim time delay is activated by a circuit breaker closing order given by the recloser.
If no faults are detected before the end of the reclaim time delay, the initial fault is considered to have been cleared.
Otherwise a new reclosing cycle is initiated.

**Safety time until recloser ready**
After manual closing of the circuit breaker, the recloser function is inhibited during this time. If a fault occurs during this time, no reclosing cycles are initiated and the circuit breaker remains permanently open.

**Dead time**
The cycle n dead time delay is activated by the circuit breaker tripping order given by the recloser in cycle n. The breaking device remains open throughout the time delay.
At the end of the cycle n dead time delay, the n+1 cycle begins, and the recloser orders the closing of the circuit breaker.

## Operation

**Initialization of the recloser**
The recloser is ready to operate if all of the following conditions are met:
- "CB control" function activated and recloser in service
- circuit breaker closed
- safety time until 79 ready elapsed
- none of the recloser inhibition conditions is true (see further on).

The "recloser ready" information may be viewed with the control matrix.

**Recloser cycles**
- case of a cleared fault:
  - following a reclosing order, if the fault does not appear after the reclaim time has run out, the recloser reinitializes and a message appears on the display (see example 1).
- case of a fault that is not cleared:
  - following instantaneous or time-delayed tripping by the protection unit, activation of the dead time associated with the first active cycle.

At the end of the dead time, a closing order is given, which activates the reclaim time. If the protection unit detects the fault before the end of the time delay, a tripping order is given and the following reclosing cycle is activated.
- after all the active cycles have been run, if the fault still persists, a final trip order is given, a message appears on the display and closing is locked out until acknowledgment takes place, according to the parameter setting of the protection function.
- closing on a fault.

If the circuit breaker closes on a fault, or if the fault appears before the end of the safety time delay, the recloser is inhibited.

**Recloser inhibition conditions**
The recloser is inhibited according to the following conditions:
- voluntary open or close order
- recloser put out of service
- receipt of a inhibtion order on the logic input
- activation of the breaker failure function (50BF)
- appearance of a switchgear-related fault, such as trip circuit fault, control fault, SF6 pressure drop
- opening of the circuit breaker by a protection unit that does not run reclosing cycles (e.g. frequency protection) pr by external tripping. In such cases, a final trip message appears.

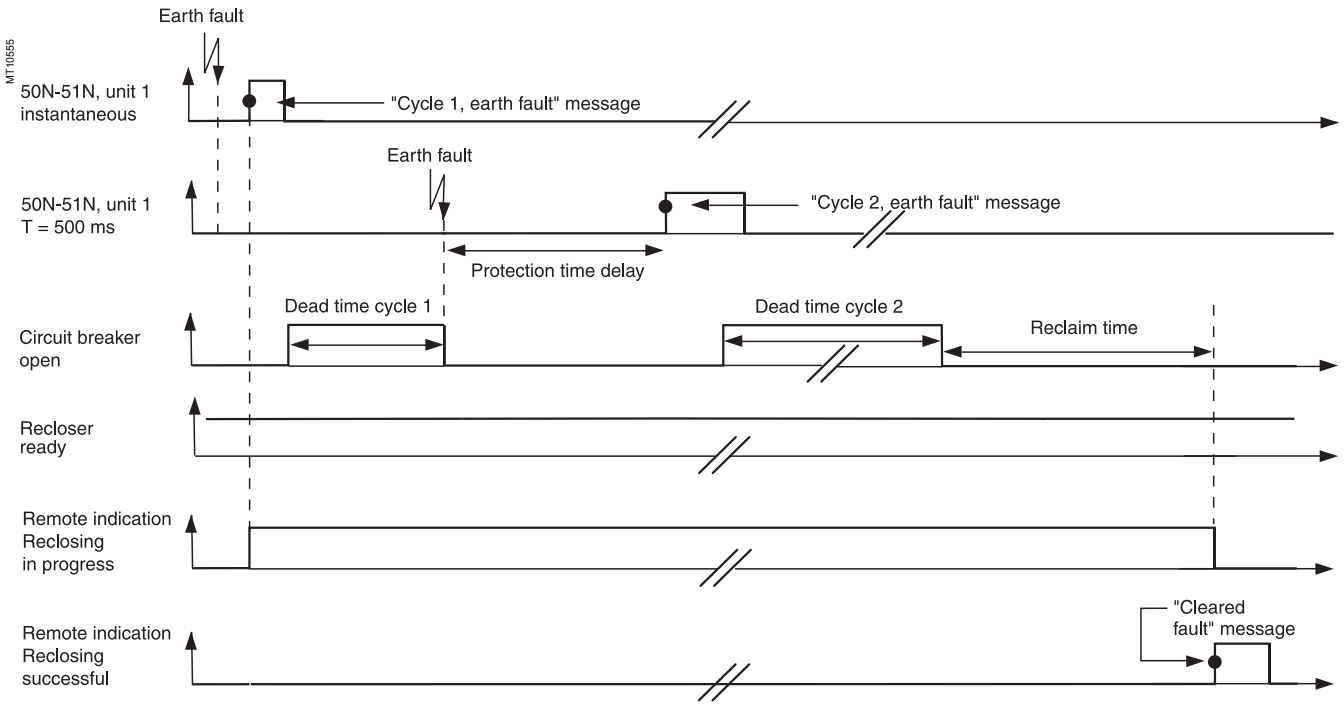
**Extension of the dead time**
If, during a reclosing cycle, reclosing of the circuit breaker is impossible because breaker recharging is not finished (following a drop in auxiliary voltage, recharging time is longer), the dead time may be extended up to the time at which the circuit breaker is ready to carry out an "Open-Close-Open" cycle. The maximum time addded to the dead time is adjustable (Twait_max). If, at the end of the maximum waiting time, the circuit breaker is still not ready, the recloser is inhibited (see example 4, 5).

## Characteristics

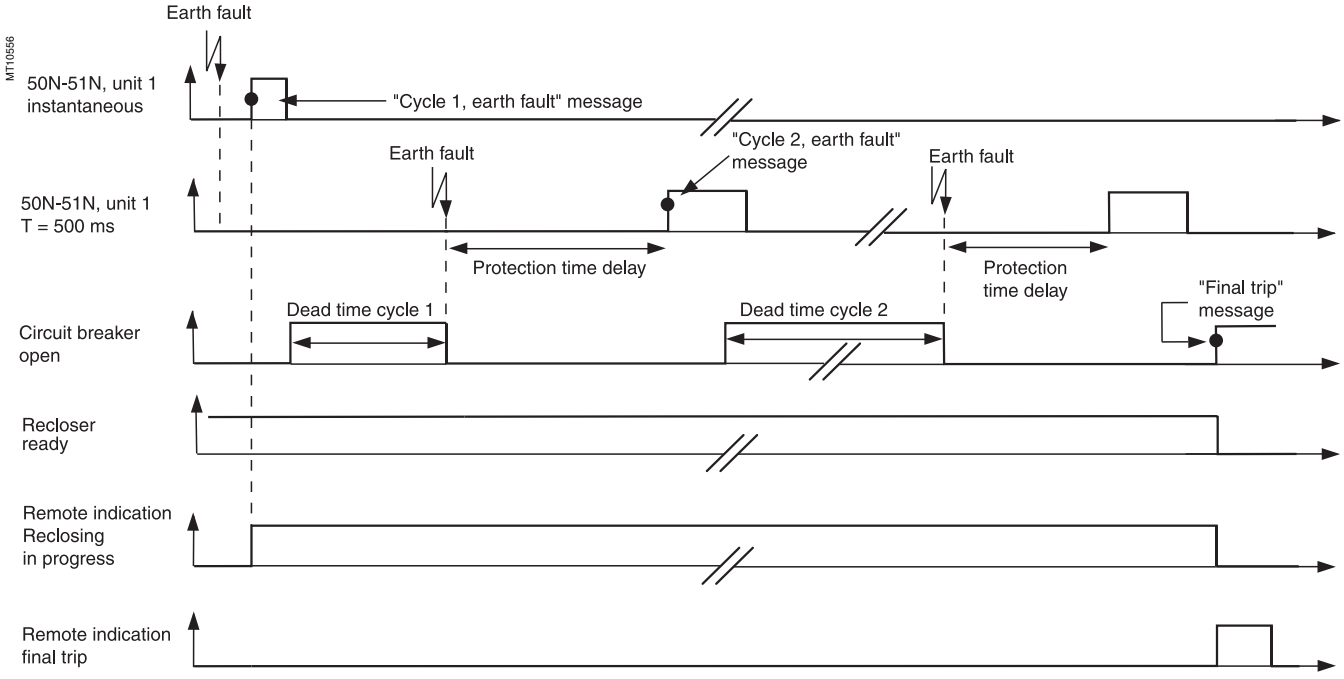
| **Reclosing cycles** | | **Setting** |
|---|---|---|
| Number of cycles | | 1 to 4 |
| Activation of cycle 1 (1) | max I 1 to 4 | inst. / delayed / no activation |
| | max I0 1 to 4 | inst. / delayed / no activation |
| | directional max I 1 to 2 | inst. / delayed / no activation |
| | directional max I0 1 to 2 | inst. / delayed / no activation |
| | V_TRIPCB output (logic equation) | activation / no activation |
| Activation of cycles 2, 3 and 4 (1) | max I 1 to 4 | inst. / delayed / no activation |
| | max I0 1 to 4 | inst. / delayed / no activation |
| | directional max I 1 to 2 | inst. / delayed / no activation |
| | directional max I0 1 to 2 | inst. / delayed / no activation |
| | V_TRIPCB output (logic equation) | activation / no activation |
| **Time delays** | | |
| Reclaim time | | 0.1 to 300 s |
| Dead time | cycle 1 | 0.1 to 300 s |
| | cycle 2 | 0.1 to 300 s |
| | cycle 3 | 0.1 to 300 s |
| | cycle 4 | 0.1 to 300 s |
| Safety time until 79 ready | | 0 to 60 s |
| Maximum additional dead time (Twait_max) | | 0.1 to 60 s |
| Accuracy | | ±2 % or 25 ms |
| Resolution | | 10 ms or 1 digit |

***(1)** If a protection function that does not activate reclosing cycles leads to circuit breaker opening, the recloser is inhibited.*

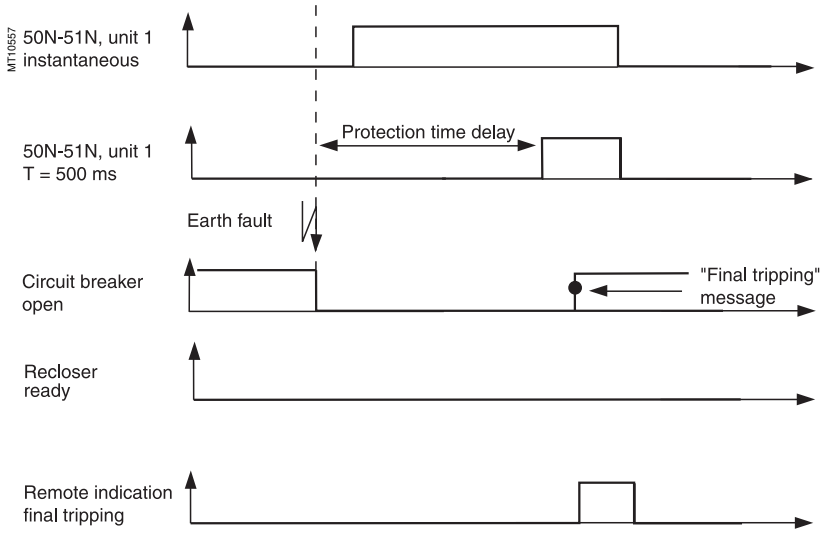
**Example 1: fault cleared after the second cycle**



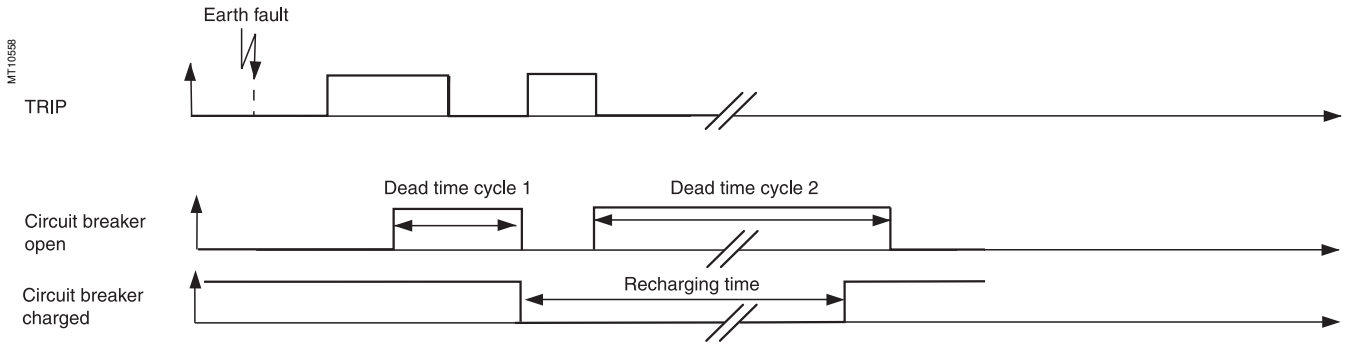

**Example 2: fault not cleared**



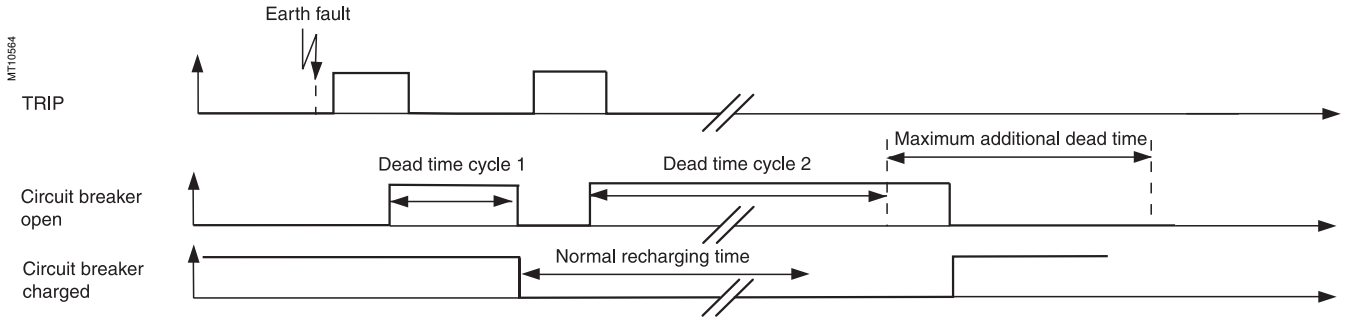
**Example 3: closing on a fault**




**Example 4: no extension of dead time**




**Example 5: extension of dead time**

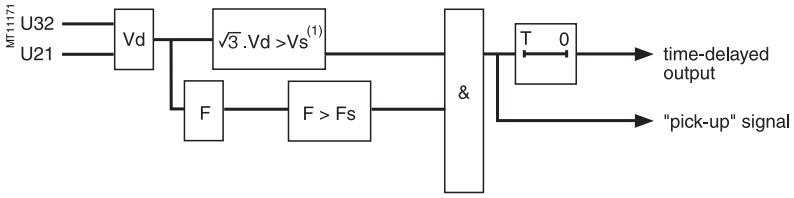


# Overfrequency
ANSI code 81H

## Operation

The protection function picks up when the positive sequence voltage frequency is above the Fs set point and the positive sequence voltage is above the Vs set point.
If a single VT is connected (U21), the function picks up when the frequency is above the Fs set point and the U21 voltage is above the Vs set point.
It includes a definite time delay T.

## Block diagram




***(1)*** *Or U21 > Vs if only one VT.*

## Characteristics

| | |
|---|---|
| **Fs set point** | |
| Setting | 50 to 55 Hz or 60 to 65 Hz |
| Accuracy (1) | ±0.02 Hz |
| Resolution | 0.1 Hz |
| Pick up / drop out difference | 0.25 Hz ±0.1 Hz |
| **Vs set point** | |
| Setting | 20 % Unp to 50 % Unp |
| Accuracy (1) | ±2 % |
| Resolution | 1 % |
| **Time delay T** | |
| Setting | 100 ms to 300 s |
| Accuracy (1) | ±2 % or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times (1)** | |
| Operation time | pick-up < 80 ms |
| Overshoot time | < 40 ms |
| Reset time | < 50 ms |

***(1)*** *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

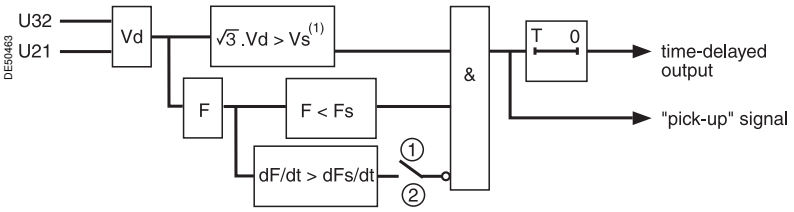
# Underfrequency
ANSI code 81L

## Operation

The function picks up when the positive sequence voltage frequency is below the Fs set point and if the positive sequence voltage is above the Vs set point.
If a single VT is connected (U21), the function picks up when the frequency is below the Fs set point and the U21 voltage is  is above the Vs set point.
It includes a definite time delay T.

The protection function includes a restraint which may be configured according to the rate of change of frequency which inhibits the protection in the event of a continuous decrease in frequency greater than the inhibition set point.
This setting avoids the tripping of all the feeders when the busbar is resupplied by remanent motor voltage following the loss of the incomer.

## Block diagram




setting: ① without restraint
② with restraint

***(1)*** *Or U21 > Vs if only one VT.*

## Characteristics

| | |
|---|---|
| **Fs set point** | |
| Setting | 40 to 50 Hz or 50 to 60 Hz |
| Accuracy (1) | ±0.02 Hz |
| Resolution | 0.1 Hz |
| Pick-up / drop out difference | 0.25 Hz ±0.1 Hz |
| **Vs set point** | |
| Setting | 20 % Unp to 50 % Unp |
| Accuracy (1) | 2 % |
| Resolution | 1 % |
| **Restraint on frequency variation** | |
| Setting | With / without |
| dFs/dt set point | 1 Hz/s to 15 Hz/s |
| Accuracy (1) | 1 Hz/s |
| Resolution | 1 Hz/s |
| **Time delay T** | |
| Setting | 100 ms to 300 s |
| Accuracy (1) | ±2 % or ±25 ms |
| Resolution | 10 ms or 1 digit |
| **Characteristic times (1)** | |
| Operation time | pick-up < 80 ms |
| Overshoot time | < 40 ms |
| Reset time | < 50 ms |

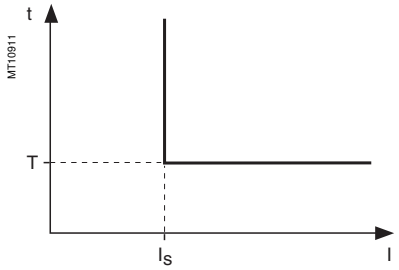
***(1)*** *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

*Presentation of tripping curve operation and settings for protection functions using:*
- *definite time*
- *IDMT*
- *timer hold.*



## Definite time protection

The tripping time is constant. The time delay is started when the set point is overrun.



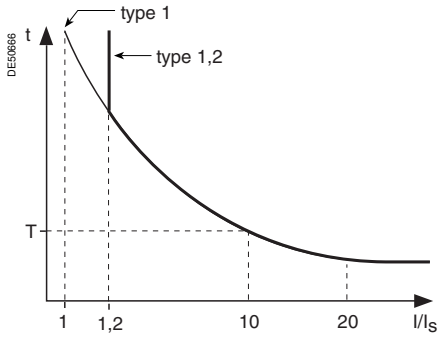

*Definite time protection principle.*

## IDMT protection

The operation time depends on the protected value (phase current, earth fault current, etc.) in accordance with standards IEC 60255-3, BS 142 and IEEE C□37112.
Operation is represented by a characteristic curve, e.g.:
- t = f(I) curve for the **phase overcurrent** function
- t = f(I0) curve for the **earth fault** function.

The rest of the document is based on t = f(I); the reasoning may be extended to other variables I0, etc.
The curve is defined by:
- its type (standard inverse, very inverse, extremely inverse, etc.)
- current setting Is which corresponds to the vertical asymptote of the curve
- time delay T which corresponds to the operation time for I = 10 Is.

These 3 settings are made chronologically in the following order: type, Is current, time delay T.
Changing the time delay T setting by x % changes all of the operation times in the curve by x %.




*IDMT protection principle.*

The tripping time for I/Is values less than 1.2 depends on the type of curve selected.

| Name of curve | Type |
|---|---|
| Standard inverse time (SIT) | 1, 2 |
| Very inverse time (VIT or LTI) | 1, 2 |
| Extremely inverse time (EIT) | 1, 2 |
| Ultra inverse time (UIT) | 1, 2 |
| RI curve | 1 |
| IEC inverse time SIT / A | 1 |
| IEC very inverse time VIT or LTI / B | 1 |
| IEC extremely inverse time EIT / C | 1 |
| IEEE moderately inverse (IEC / D) | 1 |
| IEEE very inverse (IEC / E) | 1 |
| IEEE extremely inverse (IEC / F) | 1 |
| IAC inverse | 1 |
| IAC very inverse | 1 |
| IAC extremely inverse | 1 |

- when the monitored value is more than 20 times the set point, the tripping time is limited to the value corresponding to 20 times the set point.
- if the monitored value exceeds the measurement capacity of Sepam (40 In for the phase current channels, 20 In0 for the residual current channels), the tripping time is limited to the value corresponding to the largest measurable value (40 In or 20 In0).

# General
## Tripping curves

### Current IDMT tripping curves

Multiple IDMT tripping curves are offered, to cover most applications:
- IEC curves (SIT, VIT/LTI, EIT)
- IEEE curves (MI, VI, EI)
- commonly used curves (UIT, RI, IAC).

**IEC curves**

**Equation**

$$t_d(I) = \frac{k}{\left(\frac{I}{I_s}\right)^{\alpha} - 1} \times \frac{T}{\beta}$$

| Curve type | Coefficient values | | |
|---|---|---|---|
| | k | α | β |
| Standard inverse / A | 0.14 | 0.02 | 2.97 |
| Very inverse / B | 13.5 | 1 | 1.50 |
| Long time inverse / B | 120 | 1 | 13.33 |
| Extremely inverse / C | 80 | 2 | 0.808 |
| Ultra inverse | 315.2 | 2.5 | 1 |

**RI curve**

Equation: $$t_d(I) = \frac{1}{0.339 - 0.236\left(\frac{I}{I_s}\right)^{-1}} \times \frac{T}{3.1706}$$

**IEEE curves**

**Equation**

$$t_d(I) = \left(\frac{A}{\left(\frac{I}{I_s}\right)^{p} - 1} + B\right) \times \frac{T}{\beta}$$

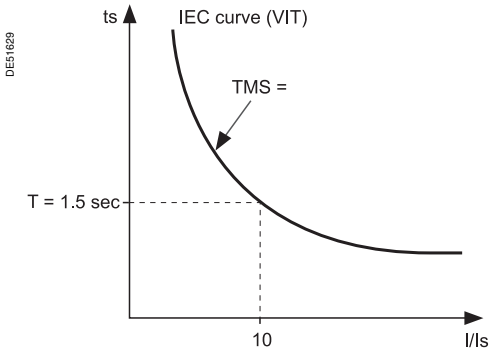
| Curve type | Coefficient values | | | |
|---|---|---|---|---|
| | A | B | p | β |
| Moderately inverse | 0.010 | 0.023 | 0.02 | 0.241 |
| Very inverse | 3.922 | 0.098 | 2 | 0.138 |
| Extremely inverse | 5.64 | 0.0243 | 2 | 0.081 |

**IAC curves**

**Equation**

$$t_d(I) = \left(A + \frac{B}{\left(\frac{I}{I_s} - C\right)} + \frac{D}{\left(\frac{I}{I_s} - C\right)^2} + \frac{E}{\left(\frac{I}{I_s} - C\right)^3}\right) x \frac{T}{\beta}$$

| Curve type | Coefficient values | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | β |
| Inverse | 0.208 | 0.863 | 0.800 | -0.418 | 0.195 | 0.297 |
| Very inverse | 0.090 | 0.795 | 0.100 | -1.288 | 7.958 | 0.165 |
| Extremely inverse | 0.004 | 0.638 | 0.620 | 1.787 | 0.246 | 0.092 |




*Example.*

## Setting of IDMT tripping curves, time delay T or TMS factor

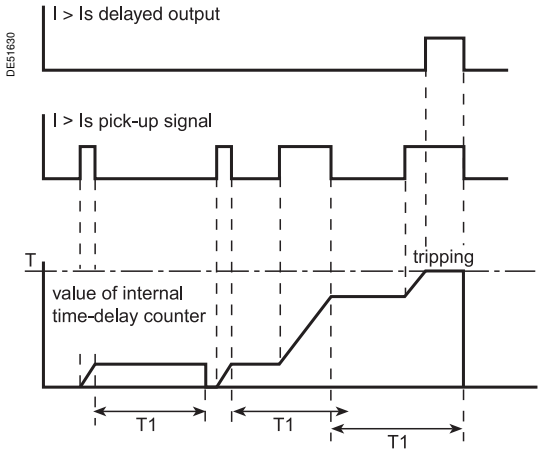
The time delays of current IDMT tripping curves (except for customized and RI curves) may be set as follows:

- time T, operating time at 10 x Is
- TMS factor, factor shown as T/β in the equations on the left.

Example: $\mathbf{t(I) = \frac{13.5}{\frac{I}{Is} - 1} \times TMS}$ where $\mathbf{TMS = \frac{T}{1.5}}$.

The IEC curve of the VIT type is positioned so as to be the same with TMS = 1 or T = 1.5 s.

3




*Detection of restriking faults with adjustable timer hold.*

## Timer hold

The adjustable timer hold T1 is used for:

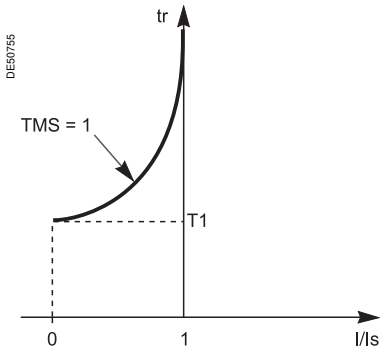
- detection of restriking faults (DT curve)
- coordination with electromechanical relays (IDMT curve).
- Timer hold may be inhibited if necessary.

**Equation for IDMT timer hold curve**

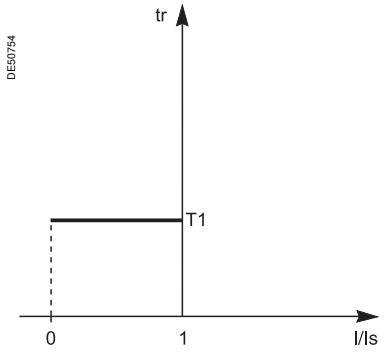
Equation: $\mathbf{t_r(I) = \frac{T1}{1 - \left(\frac{I}{Is}\right)^2} \times \frac{T}{\beta}}$ where $\mathbf{\frac{T}{\beta} = TMS}$.

T1 = timer hold setting (timer hold for I reset = 0 and TMS = 1)
T = tripping time delay setting (at 10 Is)

b = basic tripping curve value at $\mathbf{\frac{k}{10^{\alpha} - 1}}$.




*Timer hold dependent on current I.*




*Constant timer hold.*

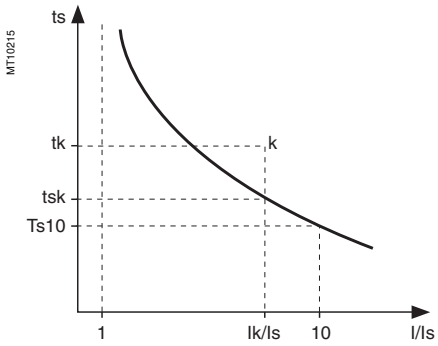
## Implementing IDMT curves: examples of problems to be solved.

**Problem 1.**
Given the type of IDMT, determine the Is current and time delay T settings.
Theoretically, the Is current setting corresponds to the maximum continuous current: it is generally the rated current of the protected equipment (cable, transformer).
The time delay T corresponds to operation at 10 Is on the curve. This setting is determined taking into account the constraints involved in discrimination with the upstream and downstream protection devices.
The discrimination constraint leads to the definition of point A on the operation curve (IA, tA), e.g. the point that corresponds to the maximum fault current for the downstream protection device.

**Problem 2.**
Given the type of IDMT, the Is current setting and a point k (Ik, tk) on the operation curve, determine the time delay setting T.
On the standard curve of the same type, read the operation time tsk that corresponds to the relative current **Ik/Is** and the operation time Ts10 that corresponds to the relative current **I/Is = 10.**

The time delay setting to be used so that the operation curve passes through the point k (Ik, tk) is:

$$\mathbf{T = Ts10 \times \frac{tk}{tsk}}$$

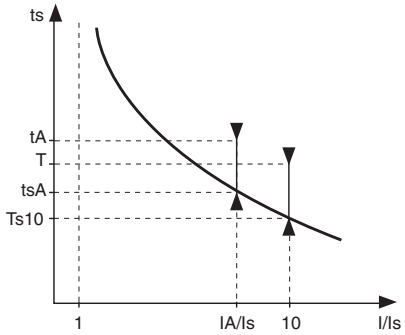



**Another practical method:**
the table below gives the values of **K = ts/ts10** as a function of **I/Is.**
In the column that corresponds to the type of time delay, read the value **K = tsk/Ts10** on the line for **Ik/Is.**
The time delay setting to be used so that the operation curve passes through point k (Ik, tk) is: **T = tk/k.**

**Example**
Data:
- type of time delay: standard inverse time (**SIT**)
- set point: Is
- a point k on the operation curve: k (3.5 Is; 4 s)

**Question:** What is the time delay T setting (operation time at 10 Is)?
Reading the table: **SIT** column, line **I/Is** = **3.5** therefore **K = 1.858**
**Answer:** The time delay setting is **T = 4/1.858 = 2.15 s**

**Problem 3.**
Given the Is current and time delay T settings for a type of time delay (standard inverse, very inverse, extremely inverse), find the operation time for a current value IA. On the standard curve of the same type, read the operation time tsA that corresponds to the relative current IA/Is and the operation time Ts10 that corresponds to the relative current **I/Is = 10.**
The operation time tA for the current IA with the Is and T settings is **tA = tsA x T/Ts10.**




**Another practical method:**
the table below gives the values of **K = ts/Ts10** as a function of **I/Is.**
In the column that corresponds to the type of time delay, read the value **K = tsA/Ts10** on the line for **IA/Is,** the operation time tA for the current IA with the Is and T settings is **tA = K . T.**

**Example**
Data:
- type of time delay: very inverse time (**VIT**)
- set point: Is
- time delay T = 0.8 s.

**Question:** What is the operation time for the current IA = 6 Is?
Reading the table: **VIT** column**,** line I/Is = 6, therefore k = 1.8

**Answer:** The operation time for the current IA is t = 1.80 x 0.8 = 1.44 s.

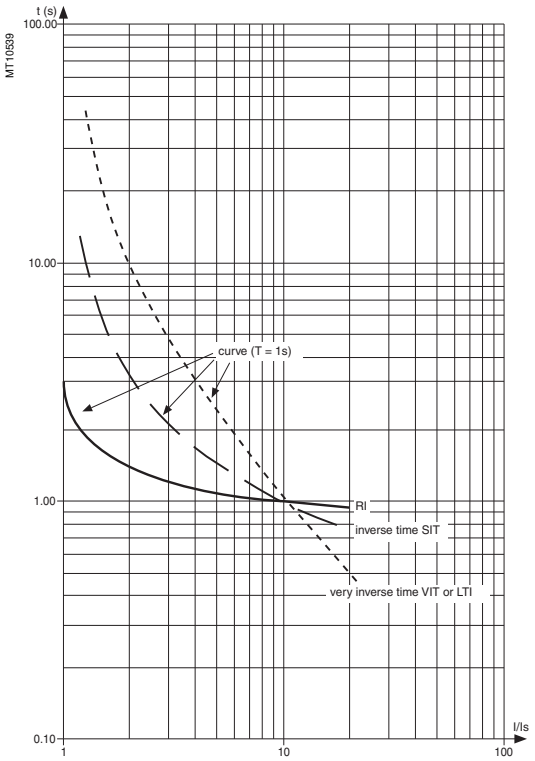
## Table of K values

| I/Is | SIT and IEC/A | VIT, LTI and IEC/B | EIT and IEC/C | UIT | RI | IEEE MI (IEC/D) | IEEE VI (IEC/E) | IEEE EI (IEC/F) | IAC I | IAC VI | IAC EI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.0** | — | — | — | — | 3.062 | — | — | — | 62.005 | 62.272 | 200.226 |
| **1.1** | 24.700 (1) | 90.000 (1) | 471.429 (1) | — | 2.534 | 22.461 | 136.228 | 330.606 | 19.033 | 45.678 | 122.172 |
| **1.2** | 12.901 | 45.000 | 225.000 | 545.905 | 2.216 | 11.777 | 65.390 | 157.946 | 9.413 | 34.628 | 82.899 |
| **1.5** | 5.788 | 18.000 | 79.200 | 179.548 | 1.736 | 5.336 | 23.479 | 55.791 | 3.891 | 17.539 | 36.687 |
| **2.0** | 3.376 | 9.000 | 33.000 | 67.691 | 1.427 | 3.152 | 10.199 | 23.421 | 2.524 | 7.932 | 16.178 |
| **2.5** | 2.548 | 6.000 | 18.857 | 35.490 | 1.290 | 2.402 | 6.133 | 13.512 | 2.056 | 4.676 | 9.566 |
| **3.0** | 2.121 | 4.500 | 12.375 | 21.608 | 1.212 | 2.016 | 4.270 | 8.970 | 1.792 | 3.249 | 6.541 |
| **3.5** | 1.858 | 3.600 | 8.800 | 14.382 | 1.161 | 1.777 | 3.242 | 6.465 | 1.617 | 2.509 | 4.872 |
| **4.0** | 1.676 | 3.000 | 6.600 | 10.169 | 1.126 | 1.613 | 2.610 | 4.924 | 1.491 | 2.076 | 3.839 |
| **4.5** | 1.543 | 2.571 | 5.143 | 7.513 | 1.101 | 1.492 | 2.191 | 3.903 | 1.396 | 1.800 | 3.146 |
| **5.0** | 1.441 | 2.250 | 4.125 | 5.742 | 1.081 | 1.399 | 1.898 | 3.190 | 1.321 | 1.610 | 2.653 |
| **5.5** | 1.359 | 2.000 | 3.385 | 4.507 | 1.065 | 1.325 | 1.686 | 2.671 | 1.261 | 1.473 | 2.288 |
| **6.0** | 1.292 | 1.800 | 2.829 | 3.616 | 1.053 | 1.264 | 1.526 | 2.281 | 1.211 | 1.370 | 2.007 |
| **6.5** | 1.236 | 1.636 | 2.400 | 2.954 | 1.042 | 1.213 | 1.402 | 1.981 | 1.170 | 1.289 | 1.786 |
| **7.0** | 1.188 | 1.500 | 2.063 | 2.450 | 1.033 | 1.170 | 1.305 | 1.744 | 1.135 | 1.224 | 1.607 |
| **7.5** | 1.146 | 1.385 | 1.792 | 2.060 | 1.026 | 1.132 | 1.228 | 1.555 | 1.105 | 1.171 | 1.460 |
| **8.0** | 1.110 | 1.286 | 1.571 | 1.751 | 1.019 | 1.099 | 1.164 | 1.400 | 1.078 | 1.126 | 1.337 |
| **8.5** | 1.078 | 1.200 | 1.390 | 1.504 | 1.013 | 1.070 | 1.112 | 1.273 | 1.055 | 1.087 | 1.233 |
| **9.0** | 1.049 | 1.125 | 1.238 | 1.303 | 1.008 | 1.044 | 1.068 | 1.166 | 1.035 | 1.054 | 1.144 |
| **9.5** | 1.023 | 1.059 | 1.109 | 1.137 | 1.004 | 1.021 | 1.031 | 1.077 | 1.016 | 1.026 | 1.067 |
| **10.0** | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| **10.5** | 0.979 | 0.947 | 0.906 | 0.885 | 0.996 | 0.981 | 0.973 | 0.934 | 0.985 | 0.977 | 0.941 |
| **11.0** | 0.959 | 0.900 | 0.825 | 0.787 | 0.993 | 0.963 | 0.950 | 0.877 | 0.972 | 0.957 | 0.888 |
| **11.5** | 0.941 | 0.857 | 0.754 | 0.704 | 0.990 | 0.947 | 0.929 | 0.828 | 0.960 | 0.939 | 0.841 |
| **12.0** | 0.925 | 0.818 | 0.692 | 0.633 | 0.988 | 0.932 | 0.912 | 0.784 | 0.949 | 0.922 | 0.799 |
| **12.5** | 0.910 | 0.783 | 0.638 | 0.572 | 0.985 | 0.918 | 0.896 | 0.746 | 0.938 | 0.907 | 0.761 |
| **13.0** | 0.895 | 0.750 | 0.589 | 0.518 | 0.983 | 0.905 | 0.882 | 0.712 | 0.929 | 0.893 | 0.727 |
| **13.5** | 0.882 | 0.720 | 0.546 | 0.471 | 0.981 | 0.893 | 0.870 | 0.682 | 0.920 | 0.880 | 0.695 |
| **14.0** | 0.870 | 0.692 | 0.508 | 0.430 | 0.979 | 0.882 | 0.858 | 0.655 | 0.912 | 0.868 | 0.667 |
| **14.5** | 0.858 | 0.667 | 0.473 | 0.394 | 0.977 | 0.871 | 0.849 | 0.631 | 0.905 | 0.857 | 0.641 |
| **15.0** | 0.847 | 0.643 | 0.442 | 0.362 | 0.976 | 0.861 | 0.840 | 0.609 | 0.898 | 0.846 | 0.616 |
| **15.5** | 0.836 | 0.621 | 0.414 | 0.334 | 0.974 | 0.852 | 0.831 | 0.589 | 0.891 | 0.837 | 0.594 |
| **16.0** | 0.827 | 0.600 | 0.388 | 0.308 | 0.973 | 0.843 | 0.824 | 0.571 | 0.885 | 0.828 | 0.573 |
| **16.5** | 0.817 | 0.581 | 0.365 | 0.285 | 0.971 | 0.834 | 0.817 | 0.555 | 0.879 | 0.819 | 0.554 |
| **17.0** | 0.808 | 0.563 | 0.344 | 0.265 | 0.970 | 0.826 | 0.811 | 0.540 | 0.874 | 0.811 | 0.536 |
| **17.5** | 0.800 | 0.545 | 0.324 | 0.246 | 0.969 | 0.819 | 0.806 | 0.527 | 0.869 | 0.804 | 0.519 |
| **18.0** | 0.792 | 0.529 | 0.307 | 0.229 | 0.968 | 0.812 | 0.801 | 0.514 | 0.864 | 0.797 | 0.504 |
| **18.5** | 0.784 | 0.514 | 0.290 | 0.214 | 0.967 | 0.805 | 0.796 | 0.503 | 0.860 | 0.790 | 0.489 |
| **19.0** | 0.777 | 0.500 | 0.275 | 0.200 | 0.966 | 0.798 | 0.792 | 0.492 | 0.855 | 0.784 | 0.475 |
| **19.5** | 0.770 | 0.486 | 0.261 | 0.188 | 0.965 | 0.792 | 0.788 | 0.482 | 0.851 | 0.778 | 0.463 |
| **20.0** | 0.763 | 0.474 | 0.248 | 0.176 | 0.964 | 0.786 | 0.784 | 0.473 | 0.848 | 0.772 | 0.450 |

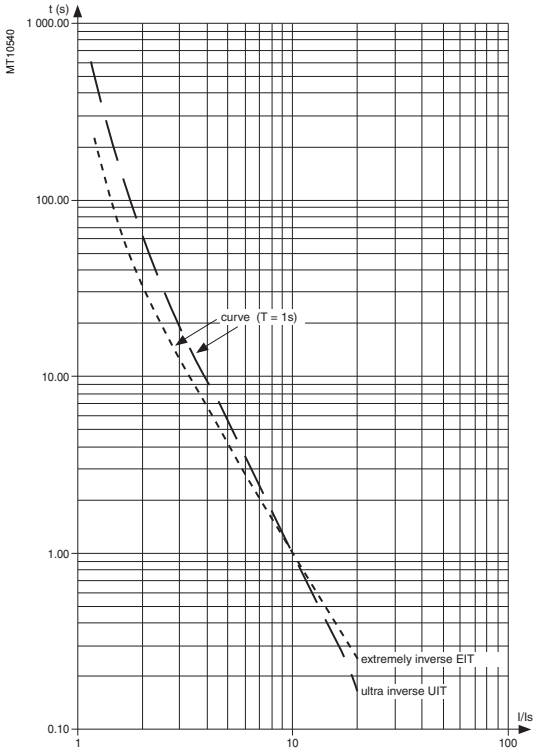
***(1)*** *Values only suitable for IEC A, B and C curves.*

# General
## Tripping curves

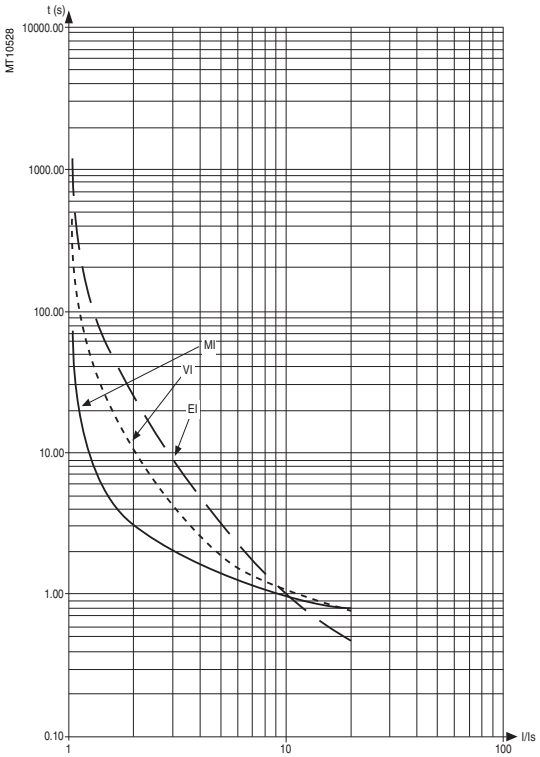
**Standard inverse time (SIT) curve**
**Very inverse time (VIT or LTI) curve**
**RI curve**



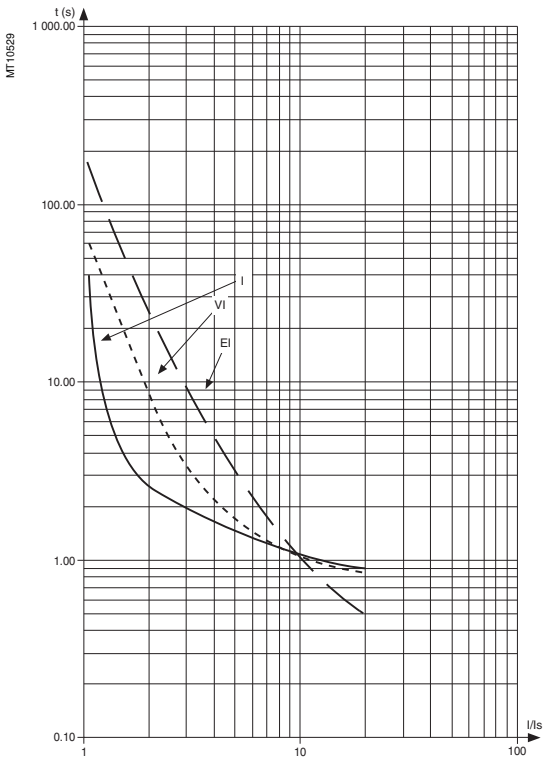

**Extremely inverse time (EIT) curve**
**Ultra inverse time (UIT) curve**




**IEEE curves**




**IAC curves**



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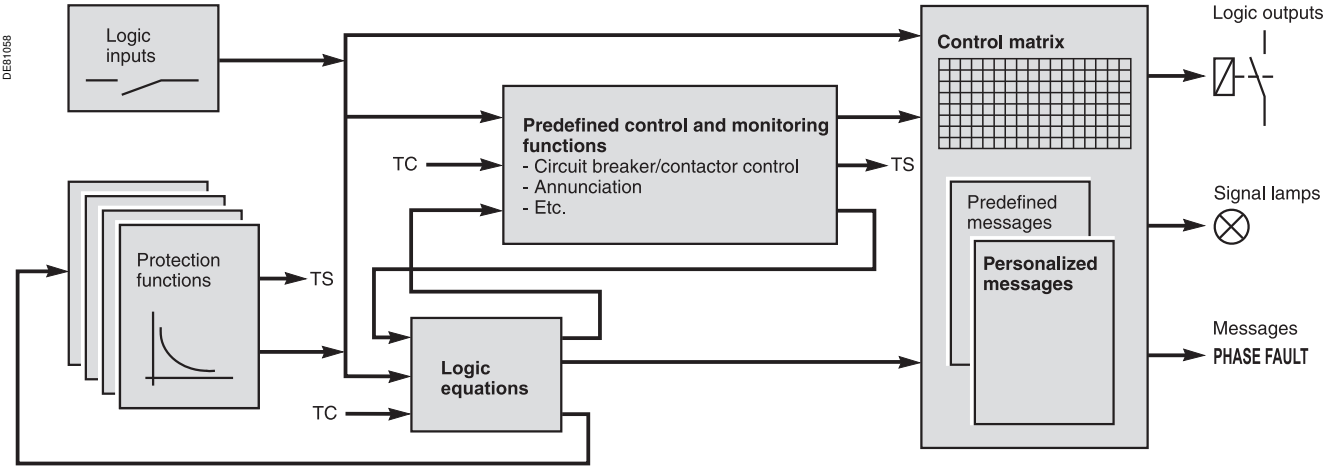
4

# Description

Sepam performs the control and monitoring functions required for electrical network operation:
■ the main control and monitoring functions are predefined and fit the applications most frequently used. They are ready to use, and are implemented by simple parameter setting after the necessary logic inputs / outputs have been assigned.
■ the predefined control and monitoring functions can be adapted for particular needs using the SFT2841 software, which offers the following customization options:
□ logic equation editor, to adapt and complete predefined control and monitoring functions
□ creation of user messages for local display
□ customization of the control matrix by changing the assignment of output relays, LEDs and display messages.

## Operating principle

The processing of each control and monitoring function may be broken down into 3 phases:
■ acquisition of input data:
□ results of protection function processing
□ external logic data, connected to the logic inputs of an optional MES120 input / output module
□ remote control orders (TC) received via the communication link
■ actual logic processing of the control and monitoring function
■ utilization of the processing results:
□ activation of output relays to trigger an actuator
□ information sent to the facility manager:
- by message and/or LED on the advanced UMI and SFT2841 software
- by remote indication (TS) via the communication link.




## Logic inputs and outputs

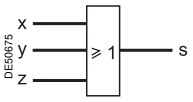
The number of Sepam inputs / outputs is adapted to fit the control and monitoring functions used.
The 4 outputs included in the Sepam series 40 base unit may be extended by adding one MES114 module with 10 logic inputs and 4 output relays.
After selecting the MES114 type required by an application, the logic inputs must be assigned to functions. The functions to which inputs are assigned are chosen from a list of available functions which covers the whole range of possible uses. The functions used can be adapted to meet needs within the limits of the logic inputs available. The inputs may also be inverted for undervoltage type operation.
A default input / output assignment is proposed for the most frequent uses.

# Definition of symbols

*This page gives the meaning of the symbols used in the block diagrams illustrating the different control and monitoring functions in this chapter.*

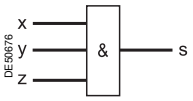
## Logic functions

■ **"OR"**



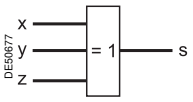

Equation: S = X + Y + Z.

■ **"AND"**




Equation: S = X x Y x Z.

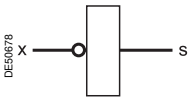
■ **exclusive "XOR"**




S = 1 if one and only one input is set to 1
(S = 1 if X + Y + Z = 1).

■ **Complement**

These functions may use the complement of one or more input values.

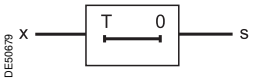


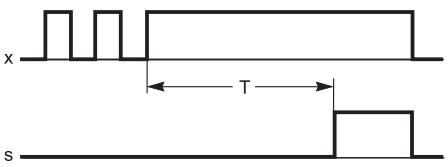

Equation: S = $\overline{X}$ (S = 1 if X = 0).

## Delay timers

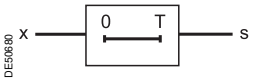
Two types of delay timers:

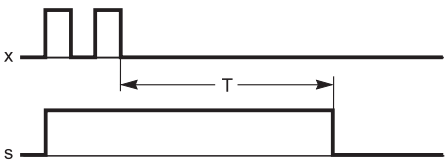
■ "on" delay timer: used to delay the appearance of a signal by a time T



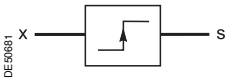

■ "off" delay timer: used to delay the disappearance of a signal by a time T.

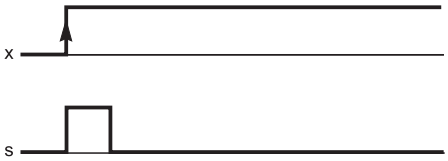


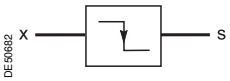

## Pulse mode operation

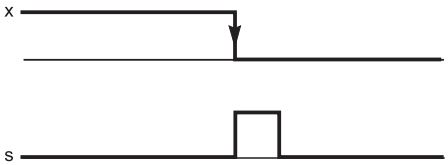
■ "on" pulse: used to create a short-duration pulse (1 cycle) each time a signal appears




■ "off" pulse: used to create a short-duration pulse (1 cycle) each time a signal disappears.

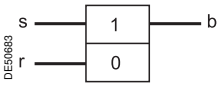


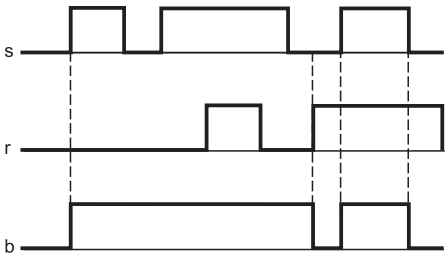




***Note:*** *the disappearance of a signal may be caused by an auxiliary power failure.*

## Bistable functions

Bistable functions may be used to store values.




Equation: B = S + $\overline{R}$ x B.

# Logic input / output assignment

Inputs and outputs may be assigned to predefined control and monitoring functions using the SFT2841 software, according to the uses listed in the table below.
■ all the logic inputs, whether or not assigned to predefined functions, may be used for the SFT2841 customization functions according to specific application needs:
□ in the control matrix, to link inputs to output relays, LED indications or display messages
□ in the logic equation editor, as logic equation variables
■ the control logic of each input may be inverted for undervoltage type operation.

| Functions | S40 | S41 | S42 | S43 | S44 | S50 | S51 | S52 | S53 | S54 | T40 | T42 | T50 | T52 | M41 | G40 | Assignment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Logic inputs** | | | | | | | | | | | | | | | | | |
| Open position | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I11 |
| Closed position | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I12 |
| Logic discrimination, blocking reception 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Logic discrimination, blocking reception 2 | | | ■ | | | | | ■ | | | | | | | | | Free |
| Switching of groups of settings A/B | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I13 |
| External reset | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External tripping 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External tripping 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External tripping 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Buchholz/gas tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Thermostat tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Pressure tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Thermistor tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Buchholz/gas alarm | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Thermostat alarm | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Pressure alarm | | | | | | | | | | | ■ | ■ | ■ | ■ | | | Free |
| Thermistor alarm | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| End of charging position | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Inhibit remote control | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| SF6 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Inhibit recloser | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | Free |
| External network synchronization | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I21 |
| Inhibit thermal overload | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Switching of thermal settings | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Motor re-acceleration | | | | | | | | | | | | | | | ■ | | Free |
| Rotor rotation detection | | | | | | | | | | | | | | | ■ | | Free |
| Inhibit undercurrent | | | | | | | | | | | | | | | ■ | | Free |
| Inhibit closing | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Open order | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Close order | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Phase voltage transformer fuse melting | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Residual voltage transformer fuse melting | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External positive active energy counter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External negative active energy counter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External positive reactive energy counter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| External negative reactive energy counter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Free |
| Downstream load start up | | | | | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | Free |
| **Logic outputs** | | | | | | | | | | | | | | | | | |
| Tripping | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | O1 |
| Trip lockout | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | O2 |
| Watchdog | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | O4 |
| Close order | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | O11 |

***Note:*** *all the logic inputs are available via the communication link and accessible in the SFT2841 matrix for other non predefined applications.*

# Standard logic input assignment

The table below lists the logic input assignment obtained with the SFT2841 software by clicking on the "Standard assignment" button.

| Functions | S40 | S41 | S42 | S43 | S44 | S50 | S51 | S52 | S53 | S54 | T40 | T42 | T50 | T52 | M41 | G40 | Standard assignment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Logic inputs** | | | | | | | | | | | | | | | | | |
| Open position | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I11 |
| Closed position | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I12 |
| Logic discrimination, blocking reception 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | I13 |
| Logic discrimination, blocking reception 2 | | | ■ | | | | | ■ | | | | | | | | | I21 |
| Switching of groups of settings A/B | | | | | | | | | | | | | | | ■ | | I13 |
| External reset | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I14 |
| External tripping 1 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | ■ | | | | | ■ | ■ | I21 |
| External tripping 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | I22 |
| External tripping 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | I23 |
| Buchholz/gas tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | I21 |
| Thermostat tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | I22 |
| Pressure tripping | | | | | | | | | | | ■ | ■ | ■ | ■ | | | I23 |
| Downstream load start up | | | | | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | I24 |
| Inhibit remote control | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I25 |
| SF6 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | I26 |

# Circuit breaker / contactor control ANSI code 94/69



## Description

Sepam is used to control breaking devices equipped with different types of closing and tripping coils:
- circuit breakers with shunt trip or undervoltage trip units (parameter setting of O1 in the front of the advanced UMI or using SFT2841)
- latching contactors with shunt trip units.

## Integrated circuit breaker / contactor control

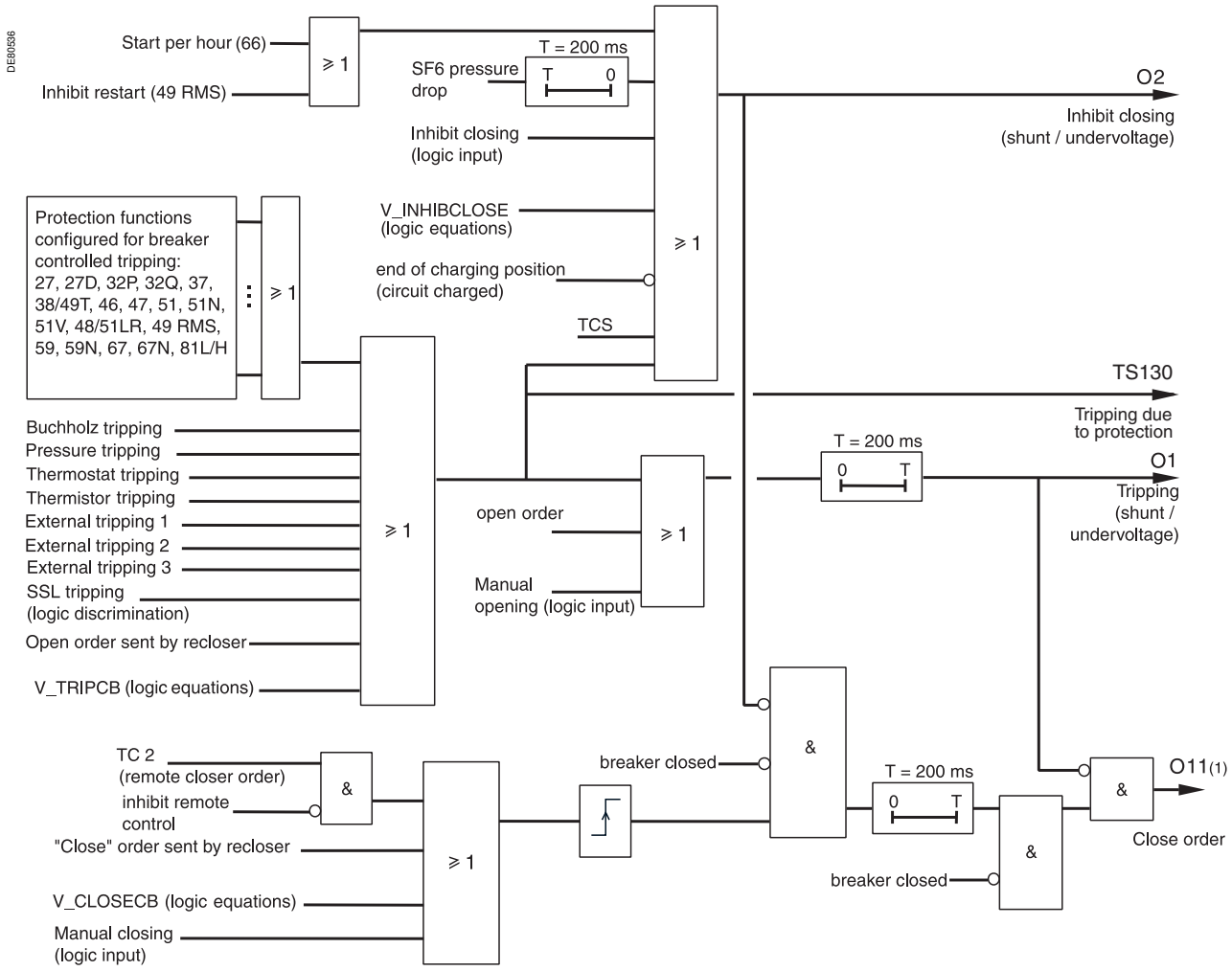
This function controls the breaking device. It is coordinated with the recloser and logic discrimination functions and includes the anti-pumping function.
It performs the following operations according to the parameter setting:
- tripping on output O1 by:
  - protection unit (units configured to trip the circuit breaker)
  - logic discrimination
  - remote control via the communication link
  - external protection
  - open order by logic input
- closing on output O11 by:
  - recloser
  - remote control via the communication link (remote control may be inhibited by the "inhibit remote control" logic input)
  - closing control by logic input
- inhibition of closing on output O2 by:
  - trip circuit fault (TCS)
  - SF6 fault
  - inhibit order by logic input.

## Circuit breaker / contactor control with lockout function (ANSI 86)

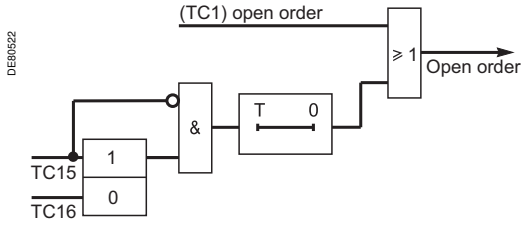
The ANSI 86 function traditionally performed by lockout relays may be carried out by Sepam using the predefined Circuit breaker / contactor control function, with latching of all tripping conditions (protection function outputs and logic inputs).
With this function, Sepam performs the following:
- grouping of all tripping conditions and breaking device control
- latching of the tripping order with inhibition of closing until the cause of tripping disappears and is acknowledged by the user
(see "Latching / acknowledgment", page 118)
- indication of the cause of tripping:
  - locally by signal lamps ("Trip" and others) and by messages on the display
  - remotely by remote indications (see “Use of remote indication bits”, page 169).

# Circuit breaker / contactor control ANSI code 94/69

## Block diagram



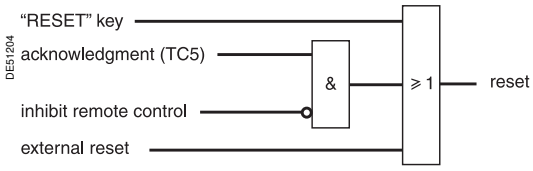

***(1)*** *The close order is only available when the MES114 option is included.*




## Monitoring Modbus S-LAN communication

### Description

The Monitoring Modbus S-LAN communication function is used to trip the circuit breaker in the event of loss of communication with the Modbus master.
This function is inhibited by default. It is activated with remote control order TC15 and can be inhibited after activation with remote control order TC16. Activation of this function is saved on loss of the auxiliary power supply.
Loss of communication with the Modbus master is detected by the Sepam unit when remote control order TC15 has not been rewritten by the Modbus master at the end of an adjustable time delay T.
The value of time delay T is set by the Modbus communication to address 5815. The setting range for the time delay is between 1 and 6553 s, in 0.1 s steps (default value 10 s).




## Latching/acknowledgment

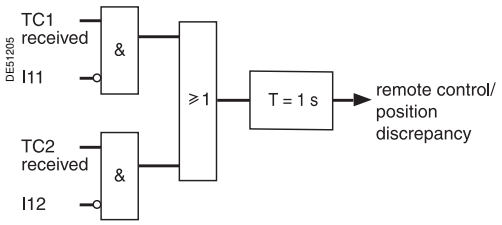
### Description

The tripping outputs of all the protection functions and all the logic inputs may be latched individually.
Logic outputs may not be latched. The logic outputs set up in pulse mode maintain pulse-type operation, even when linked to latched data.
Latched data are saved in the event of a power failure.
All latched data may be acknowledged locally on the UMI, or remotely by means of a logic input or via the communication link. The remote indication TS104 remains present after latching operations until acknowledgment has taken place.
The "Latching / acknowledgment" function associated with the "Circuit breaker / contactor control" function may be used to perform the ANSI 86 "Lockout relay" function.

### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TS** | **Binary Input** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TS104 | BI0 | 1, 160, 16 | LLN0.LEDRs.stVal |
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC5 | BO2 | 20, 160, 19 | LLN0.LEDRs.ctlVal |






## TC/circuit breaker position discrepancy

### Description

This function detects a discrepancy between the last remote control order received and the actual position of the circuit breaker.
The information is accessible via remote indication TS105.

### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TS** | **Binary Input** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TS105 | BI12 | - | - |
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC1 | BO0 | 20, 21, 1 (OFF) | CSWI1.Pos.ctlVal |
| TC2 | BO1 | 20, 21, 1 (ON) | CSWI1.Pos.ctlVal |

## Tripping

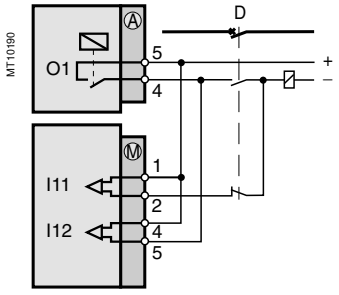
### Description

The information can be accessed via remote indication TS130.
It indicates whether a Sepam internal or external protection has tripped.

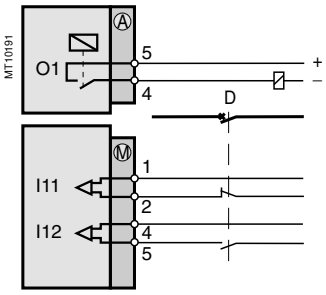
### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TS** | **Binary Input** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TS130 | BI136 | 2, 160, 68 | - |

# Circuit breaker / contactor control ANSI code 94/69
Associated functions




*Wiring for shunt trip unit.*




*Wiring for undervoltage trip unit.*

## Trip circuit supervision and open / closed matching

### Description

This supervision is designed for trip circuits:
- ■ with shunt trip units

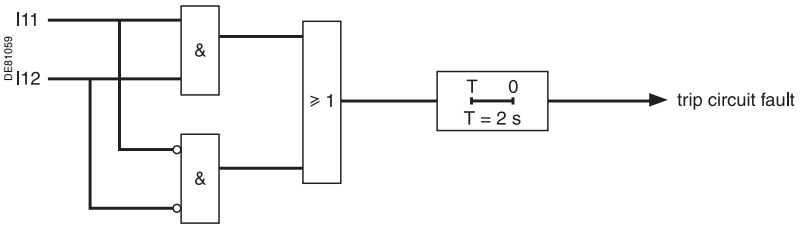
The function detects:
- □ circuit continuity
- □ loss of supply
- □ mismatching of position contacts.

The function inhibits closing of the breaking device.
- ■ with undervoltage trip units

The function detects:
- □ mismatching of position contacts, coil supervision being unnecessary in this case.

The information is accessible in the matrix and via the remote indication TS106.

### Block diagram (1)




***(1)** With MES option.*
*The function is activated if inputs I11 and I12 are set respectively as circuit breaker "open position" and circuit breaker "closed position".*

### TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TS** | **Binary Input** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TS106 | BI11 | 1, 160, 36 | XCBR1.EEHealth.stVal |

## Open and close order supervision

### Description

Following a circuit breaker open or close order, the system checks whether, after a 200 ms time delay, the circuit breaker has actually changed status.
If the circuit breaker status does not match the last order sent, a "Control fault" message and remote indication TS108 are generated.

### TS/TC equivalence for each protocol

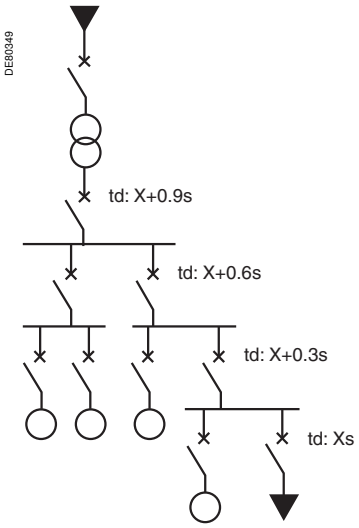
| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TS** | **Binary Input** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TS108 | BI10 | 1, 160, 36 | Command Termination - |

# Logic discrimination ANSI code 68
## Radial network

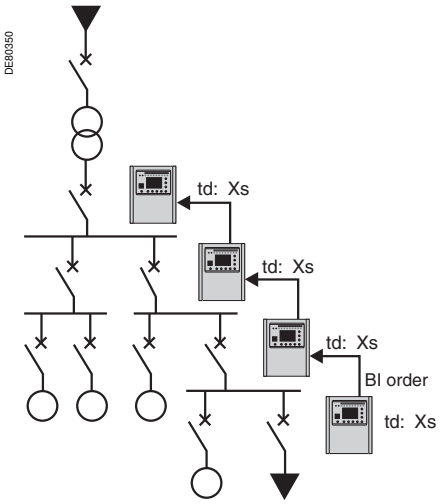
### Application

This function provides:
- full tripping discrimination
- a substantial reduction in delayed tripping of the circuit breakers located nearest the source (drawback of the classical time-based discrimination process).

The system applies to the definite time (DT) and IDMT (standard inverse time SIT, very inverse time VIT, extremely inverse time EIT and ultra inverse time UIT) phase overcurrent, earth fault and directional protection functions.



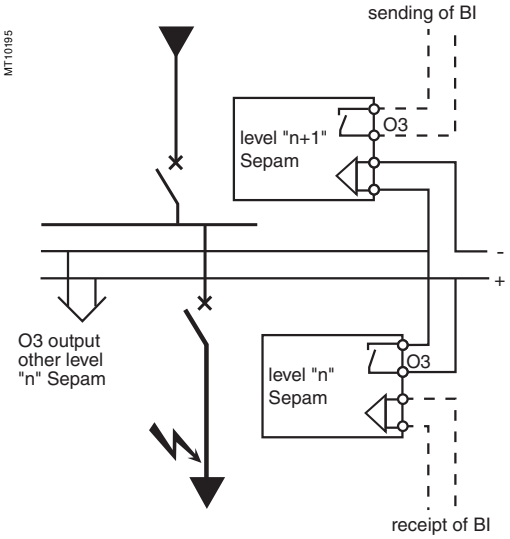

*e.g. radial distribution with use of time-based discrimination (td: tripping time definite time curves).*




*e.g.: radial distribution with use of the Sepam logic discrimination system.*

With this type of system, time delays are set in accordance with the device to be protected, without any concern for the discrimination aspect.

### Operating principle




When a fault occurs in a radial network, the fault current flows through the circuit between the source and the location of the fault:
- the protection units upstream from the fault are triggered
- the protection units downstream from the fault are not triggered
- only the first protection unit upstream from the fault should trip.

Each Sepam is capable of sending and receiving blocking information except for motor Sepams **(1)** which can only send blocking information.

When a Sepam is triggered by a fault current:
- it sends a blocking information to output O3 **(2)**
- it trips the associated circuit breaker if it does not receive a blocking information on the logic input assigned to "receipt of BI" **(3)**.

The sending of the blocking information lasts the time it takes to clear the fault. It is interrupted after a time delay that takes into account the breaking device operating time and protection unit reset time.

This system minimizes the duration of the fault, optimizes discrimination and guarantees safety in downgraded situations (wiring or switchgear failure).

### Pilot wire test

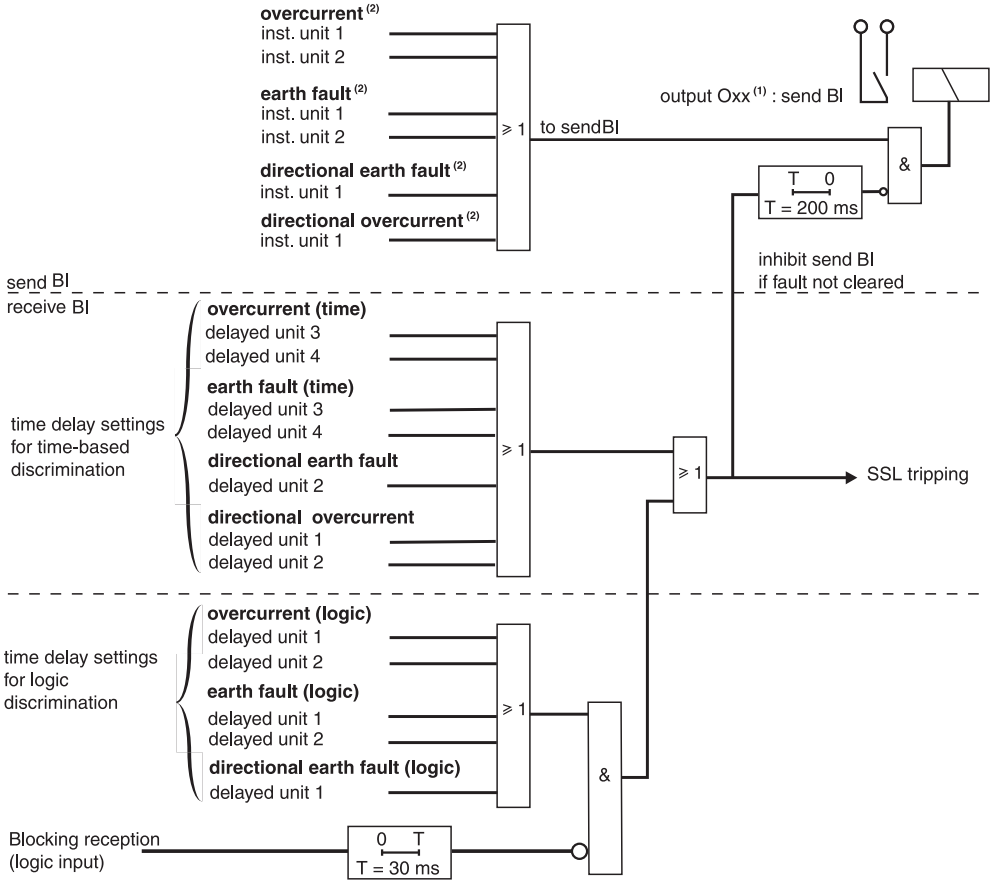
The pilot wire test may be performed using the output relay test function.

***(1)*** *Motor Sepams are not affected by the receipt of a blocking information since they are designed for loads only.*
***(2)*** *Default parameter setting.*
***(3)*** *According to parameter setting and presence of an additional MES114 module.*

# Logic discrimination
# ANSI code 68
## Radial network

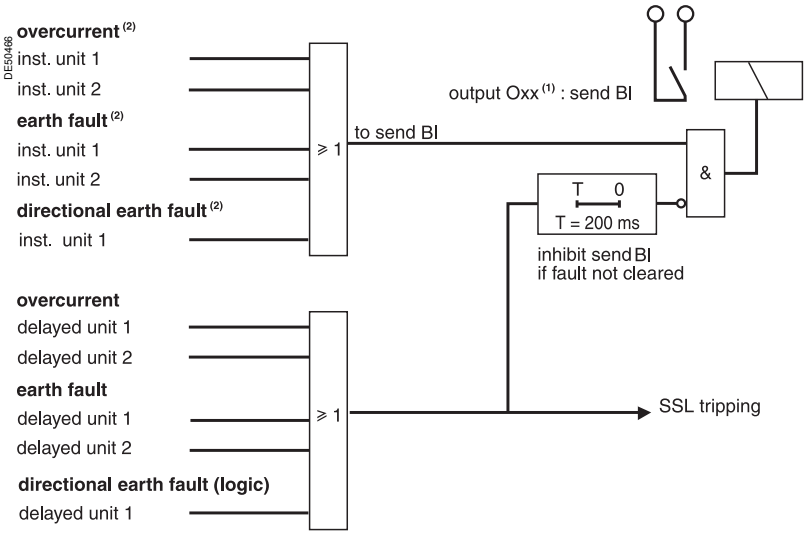
### Block diagram: Sepam S40, S41, S43, S44, S50, S51, S53, S54, T40, T42, T50, T52, G40

DE50465




### Block diagram: Sepam M40 and M41

DE50466




The protection units must be configured to trip the circuit breaker in order to be taken into account in logic discrimination.

***(1)*** *According to parameter setting (O3 by default).*

***(2)*** *Instantaneous action (inst) corresponds to protection "pick up" signal information.*

# Logic discrimination ANSI code 68
## Closed ring network

### Application

Closed ring network protection may be provided using Sepam S42 or S52 which includes the following functions:

■ 2 units of directional phase (67) and earth fault (67N) protection functions:

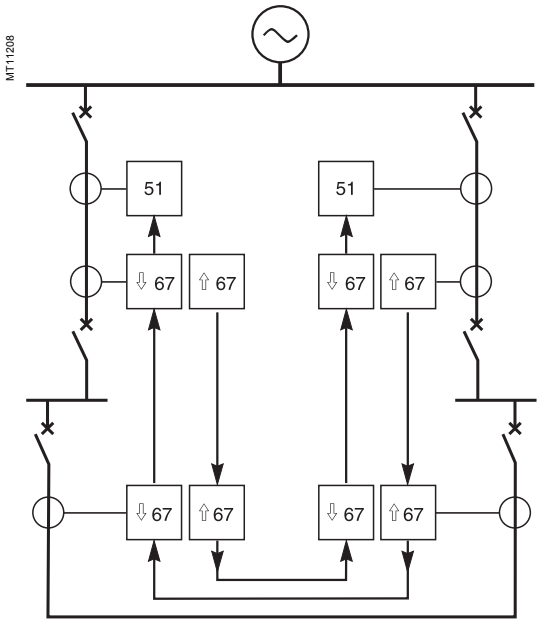
□ a unit to detect faults located in the "line" direction

□ a unit to detect faults located in the "busbar" direction

■ doubled logic discrimination function, with:

□ sending of 2 blocking information, according to the direction of the fault detected

□ receipt of 2 blocking information to block the directional protection relays according to their detection direction.




⇩, ⇧ : *direction of 67/67N protection functions*

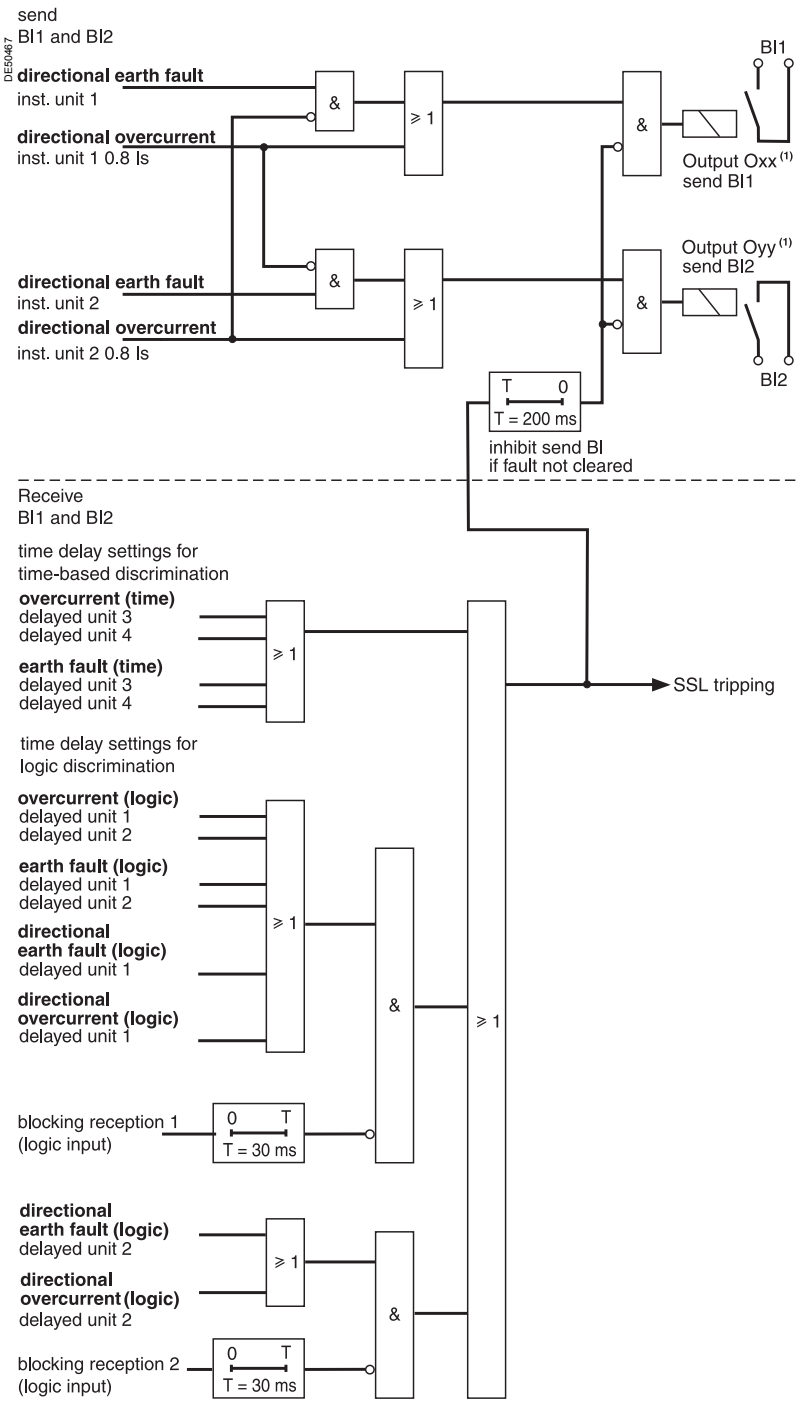
: *direction of blocking signals*

With the combination of the directional protection functions and the logic discrimination function, the faulty section may be isolated with minimum delay by the tripping of the circuit breakers on either side of the fault.

Blocking information are prepared by protection functions 67 and 67N.
Priority is given to protection function 67: when protection functions 67 and 67N detect faults in opposite directions at the same time, the blocking information is determined by the direction of the fault detected by protection function 67.

The instantaneous output of protection function 67, activated at 80 % of the Is set point, is used to send blocking information. This avoids uncertainly when the fault current is close to the Is set point.

### Block diagram: Sepam S42, S52

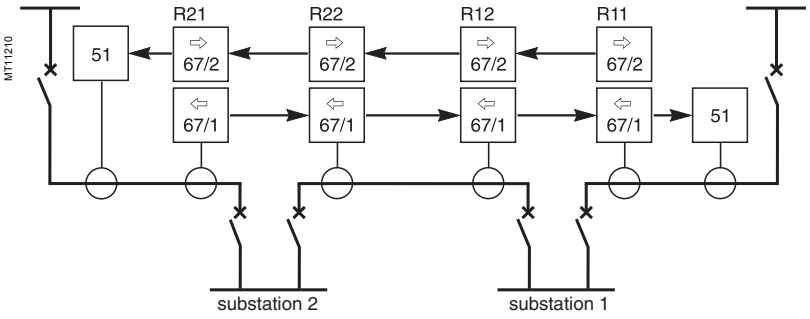



***(1)*** *According to parameter setting (by default): O3 for send BI1 and O12 for send BI2.*

# Logic discrimination
# ANSI code 68
## Closed ring network

### Example of closed ring protection function setting:

Case of a closed ring with two substations, each of which comprises two Sepam S42 or S52 relays, marked R11, R12 and R21, R22.




⇨, ⇦ : *direction of 67/67N protection functions*

: *direction of blocking signals*

Starting at one end of the ring, the detection direction of units 1 and 2 of the directional protection functions should be alternated between line and busbar.

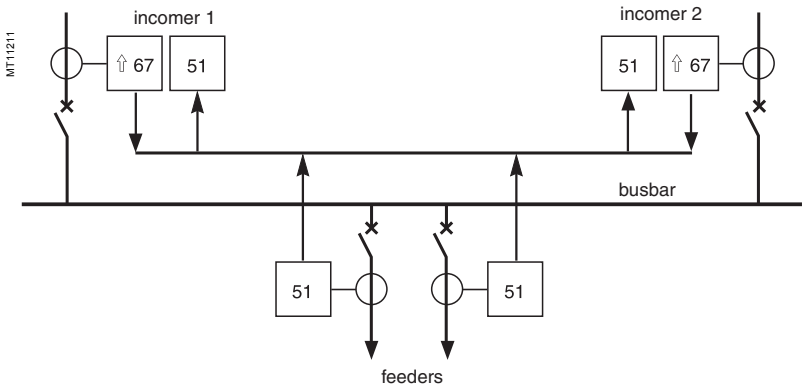
Example of setting of the different Sepam with logic discrimination:

| **Substation 1** | |
|---|---|
| **Sepam S42 or S52 no. R11** | **Sepam S42 or S52 no. R12** |
| ■ Logic input/output assignment:<br>I13: blocking reception 1<br><br>O3: send blocking information BI1<br>O12: send blocking information BI2<br>■ 67, 67N, unit 1:<br>tripping direction = busbar<br>■ 67, 67N, unit 2:<br>tripping direction = line | ■ Logic input/output assignment:<br>I13: blocking reception 1<br>I14: blocking reception 2<br>O3: send blocking information BI1<br>O12: send blocking information BI2<br>■ 67, 67N, unit 1:<br>tripping direction = line<br>■ 67, 67N, unit 2:<br>tripping direction = busbar |
| **Substation 2** | |
| **Sepam S42 or S52 no. R22** | **Sepam S42 or S52 no. R21** |
| ■ Logic input/output assignment:<br>I13: blocking reception 1<br>I14: blocking reception 2<br>O3: send blocking information BI1<br>O12: send blocking information BI2<br>■ 67, 67N, unit 1:<br>tripping direction = busbar<br>■ 67, 67N, unit 2:<br>tripping direction = line | ■ Logic input/output assignment:<br>I13: blocking reception 1<br><br>O3: send blocking information BI1<br>O12: send blocking information BI2<br>■ 67, 67N, unit 1:<br>tripping direction = line<br>■ 67, 67N, unit 2:<br>tripping direction = busbar |

# Logic discrimination
# ANSI code 68
## Substation with 2 parallel incomers

### Application

Substations supplied by 2 (or more) parallel incomers may be protected using Sepam S42 or S52, or Sepam T42 or T52, by a combination of directional phase (67) and earth fault (67N) protection functions, with the logic discrimination function.




⇧ *: direction of 67/67N protection functions*

▲ *: direction of blocking signals*

To avoid both incomers tripping when a fault ocurs upstream from one incomer, the incomer protection devices must operate as follows:

■ protection 67 of the faulty incomer detects the fault current in the "line" direction, the protection tripping direction:

□ sends a blocking information to inhibit the phase overcurrent protection functions (50/51) of both incomers

□ and trips the incomer circuit breaker

■ protection function 67 of the fault-free incomer is insensitive to fault current in the "busbar" direction.

### Examples of parallel incomer protection function setting

**Protection by Sepam S42 or S52**

■ logic input/output assignment:

□ I13: blocking reception 1 - **Do not assign any inputs to blocking reception 2**

□ O3: send blocking information BI1

■ protection function 67 unit 1: tripping direction = line

□ instantaneous output: send blocking information BI1

□ time-delayed output: inhibited by receipt of BI1 on I13

■ protection function 67, unit 2: tripping direction = line

□ time-delayed output: tripping of circuit breaker triggered by fault upstream from incomer (not inhibited since no input is assigned to blocking reception 2).

**Protection by Sepam T42 or T52**

■ logic input/output assignment:

□ I13: blocking reception 1

□ O3: send blocking information BI1

■ protection function 67 unit 1: tripping direction = line

□ instantaneous output: send blocking information BI1

□ time-delayed output: tripping of circuit breaker triggered by a fault upstream from the incomer (not inhibited by the receipt of BI1 on I13)

■ protection function 67, unit 2: if necessary.

# Disturbance recording triggering

## Description

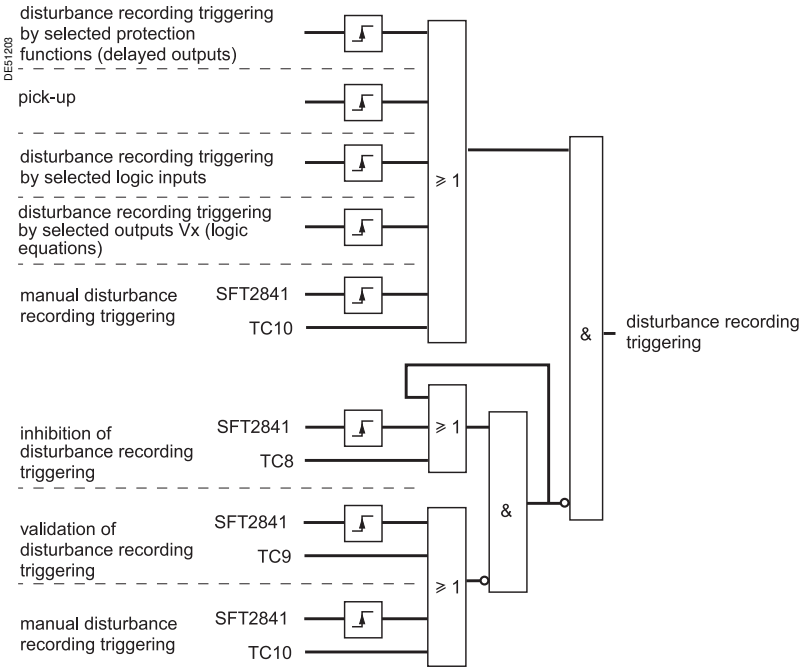
The recording of analog and logic signals may be triggered by different events, according to control matrix parameter setting or by manual action:

- triggering by the grouping of all pick-up signals of the protection functions in service
- triggering by the delayed outputs of selected protection functions
- triggering by selected logic inputs
- triggering by selected outputs Vx (logic equations)
- manual triggering by a remote control order (TC10)
- manual triggering via the SFT2841 software tool.

Disturbance recording may be:

- inhibited via the SFT2841 software or by remote control order (TC8)
- validated via the SFT2841 software or by remote control order (TC9).

## Block diagram




## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC8 | BO3 | - | RDRE1.RcdInh.ctlVal |
| TC9 | BO4 | - | RDRE1.RcdInh.ctlVal |
| TC10 | BO5 | - | RDRE1.RcdTrg.ctlVal |

# Switching of groups of settings



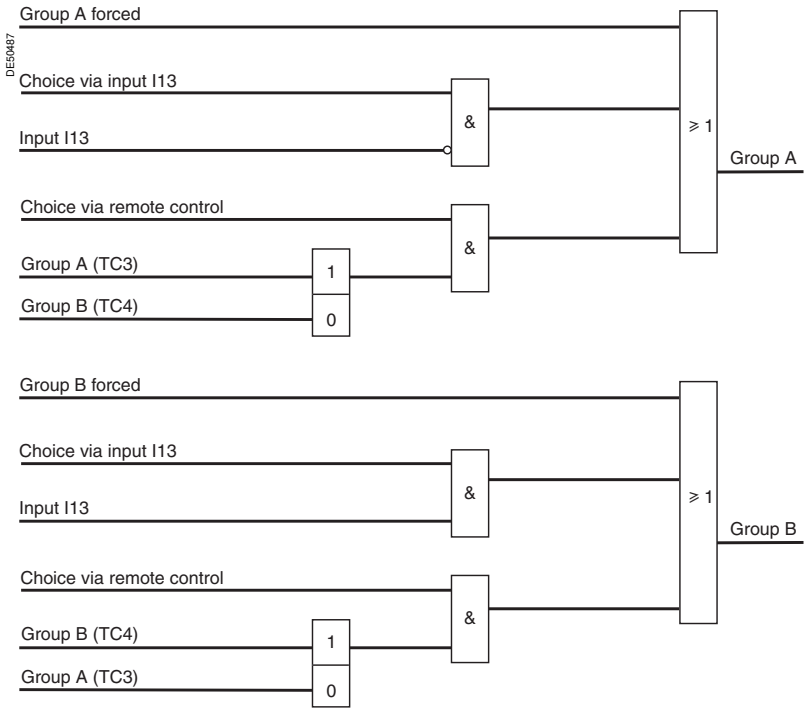
## Description

There are two groups of settings, group A / group B, for the phase overcurrent, earth fault and, directional phase overcurrent and directional earth fault protection functions. Switching from one group of settings to another makes it possible to adapt the protection characteristics to suit the electrical environment of the application (change of earthing system, transition to local production, ...). The switching of settings is global and therefore applies to all the units of the protection functions mentioned above.

The setting switching mode is determined by parameter setting:

- switching according to the position of logic input I13 (0 = group A, 1 = group B)
- switching by remote control (TC3, TC4)
- forced group A or group B.

## Block diagram




## TS/TC equivalence for each protocol

| Modbus | DNP3 | IEC 60870-5-103 | IEC 61850 |
|---|---|---|---|
| **TC** | **Binary Output** | **ASDU, FUN, INF** | **LN.DO.DA** |
| TC3 | BO8 | 20, 160, 23 | LLN0.SGCB.SetActiveSettingGroup |
| TC4 | BO9 | 20, 160, 24 | LLN0.SGCB.SetActiveSettingGroup |

# Local indication ANSI code 30

Events may be indicated on the front panel of Sepam by:
- appearance of a message on the display of the advanced UMI
- lighting up of one of the 9 yellow signal lamps.

## Message type indication

**Predefined messages**
All the messages connected to the standard Sepam functions are predefined and available in two language versions:
- in English, factory messages, not modifiable
- in the local language, according to the version delivered.

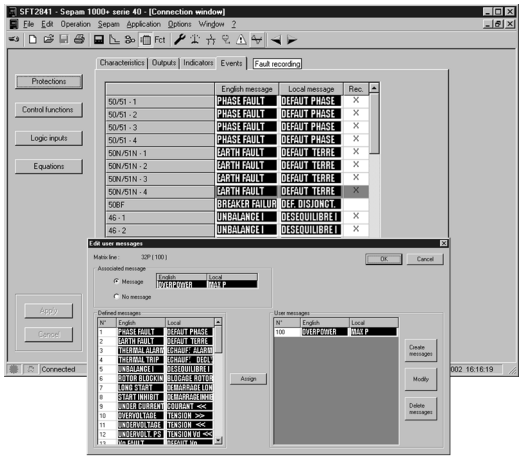
The language version is chosen at the time of Sepam parameter setting.
The messages are visible on the display units of Sepams equipped with the advanced UMI and in the SFT2841 Alarms screen. The predefined messages are identified by a number on the SFT2841 software screens.
- The number and type of predefined messages depend on the type of Sepam. The table below gives the complete list of all predefined messages.

## List of messages

| **Functions** | **English** (factory) | **Local language** (e.g. French) | **Message number** |
|---|---|---|---|
| Phase overcurrent | PHASE FAULT (2) | DEFAUT PHASE (2) | 1 |
| Voltage-restrained phase overcurrent | O/C V RESTRAINT (2) | DEF. PHASE RET.U (2) | 50 |
| Earth fault | EARTH FAULT | DEFAUT TERRE | 2 |
| Breaker failure | BREAKER FAILURE | DEF. DISJONCT. | 40 |
| Negative sequence/unbalance | UNBALANCE I | DESEQUILIBRE I | 5 |
| Broken conductor detection | BROKEN CONDUCT. | RUPTURE COND. | 52 |
| Directional phase overcurrent | DIR. PHASE FAULT (2) | DEFAUT PHASE DIR. (2) | 38 |
| Directional earth fault | DIR. EARTH FAULT | DEFAUT TERRE DIR. | 37 |
| Active overpower | REVERSE P | RETOUR P | 36 |
| Reactive overpower | REVERSE Q | RETOUR Q | 46 |
| Thermal overload | THERMAL ALARM | ECHAUF$^{T}$. ALARME | 3 |
| | THERMAL TRIP | ECHAUF$^{T}$. DECL$^{T}$. | 4 |
| | START INHIBIT | DEMARRAGE INHIBE | 8 |
| Locked rotor/ | ROTOR BLOCKING | BLOCAGE ROTOR | 6 |
| Locked rotor at startup | ST$^{RT}$ LOCKED ROT$^{R}$. | BLOC ROTOR DEM | 27 |
| Excessive starting time | LONG START | DEMARRAGE LONG | 7 |
| Number of starts | START INHIBIT | DEMARRAGE INHIBE | 8 |
| Phase undercurrent | UNDER CURRENT | COURANT << | 9 |
| Overvoltage | OVERVOLTAGE (3) | TENSION >> (3) | 10 |
| Undervoltage | UNDERVOLTAGE (3) | TENSION << (3) | 11 |
| Positive sequence undervoltage | UNDERVOLT. PS | TENSION Vd<< | 12 |
| | ROTATION | ROTATION | 39 |
| Neutral voltage displacement | V0 FAULT | DEFAUT V0 | 13 |
| Overfrequency | OVER FREQ. | FREQUENCE >> | 14 |
| Underfrequency | UNDER FREQ. | FREQUENCE << | 15 |
| Negative sequence overvoltage | UNBALANCE V | DESEQUILIBRE V | 18 |
| Temperature (RTDs) (1) | OVER TEMP. ALM | T° ALARME | 16 |
| | OVER TEMP. TRIP | T°. DECL$^{T}$. | 17 |
| | RTD'S FAULT (1 to 2) | DEFAUT SONDES (1 à 2) | 32, 51 |
| Thermostat | THERMOS$^{T}$. ALARM | THERM$^{OT}$. ALARME | 26 |
| | THERMOS$^{T}$. TRIP | THERMOS$^{T}$. DECL$^{T}$. | 23 |
| Buchholz | BUCHHOLZ ALARM | BUCHH ALARME | 25 |
| | BUCHH/GAS TRIP | BUCHH/GAZ DECL$^{T}$. | 22 |
| Pressure | PRESSURE ALM. | PRESSION ALARME | 42 |
| | PRESSURE TRIP | PRESSION DECL$^{T}$. | 24 |
| Thermistor PTC/NTC | THERMIS$^{T}$. ALARM | THERM$^{IST}$. ALARME | 44 |
| | THERMIS$^{T}$. TRIP | THERMIS$^{T}$. DECL$^{T}$. | 45 |
| External tripping x (1 to 3) | EXT. TRIP x (1 to 3) | DECL$^{T}$. EXT. x (1 à 3) | 33, 34, 35 |
| Trip circuit supervision | TRIP CIRCUIT | CIRCUIT DECL$^{T}$. | 20 |
| Circuit breaker control | CONTROL FAULT | DEFAUT COM$^{DE}$. | 21 |
| Recloser | CYCLE x (1 to 4) **(4)** | CYCLE x (1 à 4) **(4)** | 28, 29, 30, 31 |
| Recloser | FINAL TRIP | DECL$^{T}$ DEFINITIF. | 41 |
| Recloser | CLEARED FAULT | DEFAUT ELIMINE | 19 |
| SF6 | SF6 LOW | BAISSE SF6 | 43 |
| Phase VT supervision | VT FAULT | DEFAUT TP | 48 |
| V0 VT supervision | VT FAULT V0 | DEFAUT TP V0 | 49 |
| CT supervision | CT FAULT | DEFAUT TC | 47 |

***(1)*** *RTD FAULT message: refer to the maintenance chapter.*
***(2)*** *With indication of the faulty phase.*
***(3)*** *With indication of the faulty phase, when used with phase-to-neutral voltage.*
***(4)*** *With indication of the protection unit that has initiated the cycle (phase fault, earth fault, etc.).*

# Local indication ANSI code 30




*Personalized message editor.*

## Personalized user messages

30 additional messages may be created using the SFT2841 software to link a message to a logic input or the result of a logic equation, for example, or to replace a predefined message by a personalized message.

**Personalized user message editor in SFT2841**

The personalized message editor is integrated in the SOFT2841 software tool and may be accessed in connected or unconnected mode, from the control matrix screen:

- display on the screen the "Event" tab associated with "Protection": the predefined messages associated with the protection functions appear
- double-click on one of the messages displayed to activate the personalized message editor.

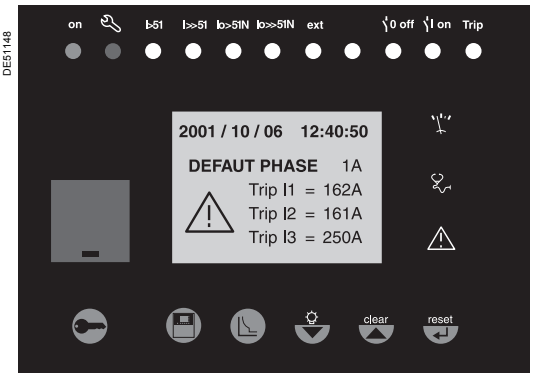
**Personalized message editor functions**

- creation and modification of personalized messages:
  - in English and the local language
  - by text input or importing of an existing bitmap file (*.bmp) or by point to point drawing
- deletion of personalized messages
- assignment of predefined or personalized messages to an event defined in the control matrix:
  - from the control matrix screen, "Events" tab, double-click on the event to be linked to a new message
  - select the new predefined or personalized message, from among the messages presented
  - and "Assign" it to the event.

The same message may be assigned to several events, with no restriction.

## Message display in SFT2841

- the predefined messages are stored in Sepam's memory and appear:
  - written out in text format in connected mode
  - in code number format in unconnected mode
- the personalized messages are saved with the other Sepam parameters and protection settings and are displayed written out in text format in connected and unconnected modes.




*Alarm message on the advanced UMI.*

## Message processing on the advanced UMI display

When an event occurs, the related message appears on the advanced UMI display.

The user presses the clear key to clear the message and be able to consult all the advanced UMI screens in the normal fashion.
The user must press the reset key to acknowledge latched events (e.g. protection outputs).
The list of messages remains accessible in the alarm history (⚠ key), in which the last 16 messages are stored. The last 250 messages may be consulted with the SFT2841 software.

To delete the messages stored in the alarm history:

- display the alarm history on the advanced UMI
- press the clear key.

## Signal lamp type indication

The 9 yellow signal lamps on the front of Sepam are assigned by default to the following events:

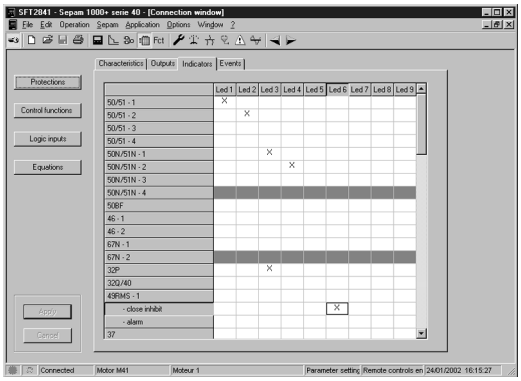
| Signal lamp | Event | Label on front panel |
|---|---|---|
| LED 1 | Tripping of protection 50/51 unit 1 | I>51 |
| LED 2 | Tripping of protection 50/51 unit 2 | I>>51 |
| LED 3 | Tripping of protection 50N/51N unit 1 | Io>51N |
| LED 4 | Tripping of protection 50N/51N unit 2 | Io>>51N |
| LED 5 | | Ext |
| LED 6 | | |
| LED 7 | Circuit breaker open (I11) (1) | 0 off |
| LED 8 | Circuit breaker closed (I12) (1) | I on |
| LED 9 | Tripping by circuit breaker control | Trip |

***(1)** Assignment by default with MES114.*

The default parameter setting may be personalized using the SFT2841 software:

- the assignment of signal lamps to events is to be defined in the control matrix screen, "LEDs" tab
- editing and printing of personalized labels are proposed in the "Sepam" menu.

# Control matrix



MT11186

*SFT2841: control matrix.*

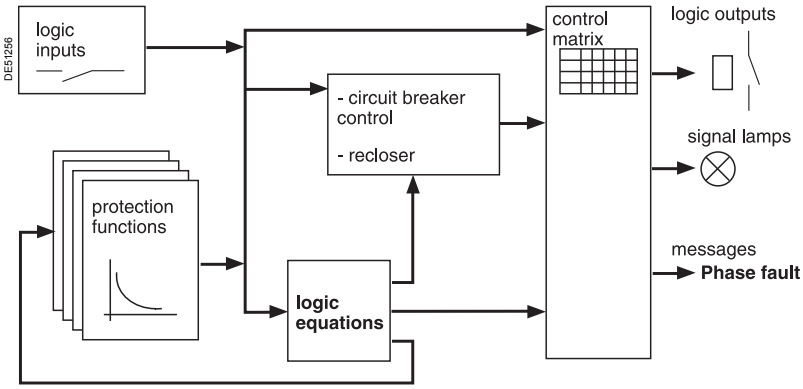
The control matrix is used for simple assignment of the logic outputs and signal lamps to information produced by the protection units, program logic and logic inputs. Each column creates a logic OR between all the lines selected.
The matrix may also be used to display the alarms connected to the information. It guarantees the consistency of the parameter setting with the predefined functions. The following data are managed in the control matrix and may be set using the SFT2841 software tool.

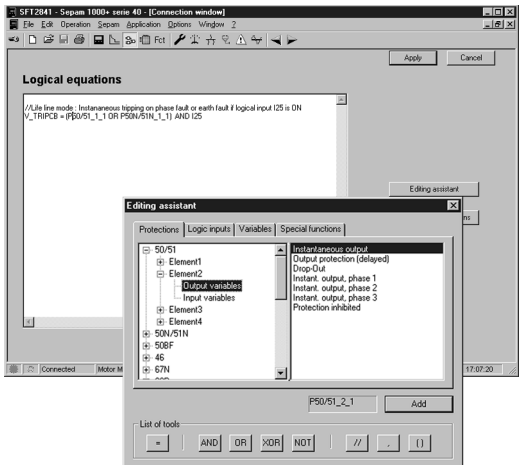
| Data | Meaning | Comments |
|---|---|---|
| **"Protections" button** | | |
| All of the application protection functions | Protection time-delayed output and additional outputs when applicable | Additional actions in the "Characteristic" tab:<br>In service / out of service<br>Protection latching<br>Participation of the protection unit in circuit breaker tripping |
| **"Control functions" button** | | |
| Tripping | Tripping by the circuit breaker control function | Forced on O1 |
| Inhibit closing | Inhibition of closing by the circuit breaker control function | Forced on O2 |
| Closing | Closing by the circuit breaker control function | Forced on O11 (requires an MES114) |
| Pick-up | Logical OR of the instantaneous output of all protection units | |
| Drop-out | A protection unit time delay counter has not yet gone back to 0. | |
| TCS fault | Trip circuit fault | |
| Remote control discrepancy / Circuit breaker position | Discrepancy between the last state ordered by the remote monitoring and control system and the position of the circuit breaker | |
| CB control fault | A circuit breaker open or close order has not been executed | |
| Fault recording inhibition | Disturbance recording inhibited | |
| Sending of blocking information BI1 | Sending of the blocking information to the following Sepam in logic discrimination chain 1 | O3 by default |
| Sending of blocking information BI2 | Sending of the blocking information to the next Sepam in logic discrimination chain 2 | O12 by default<br>On Sepam S42 or S52 only |
| Tripping by logic discrimination | Tripping order sent by the logic discrimination function | Only when the logic discrimination function is used without the circuit breaker control function |
| Cleared fault | The recloser function has sucessfully reclosed | Impulse type output |
| Final trip | The circuit breaker is definitively open after the reclosing cycles | Impulse type output |
| Recloser ready | The recloser is ready to carry out the cycles | |
| Recloser in service | The recloser is in service | |
| Recloser cycle 1 | Cycle 1 in progress | |
| Recloser cycle 2 | Cycle 2 in progress | |
| Recloser cycle 3 | Cycle 3 in progress | |
| Recloser cycle 4 | Cycle 4 in progress | |
| Reverse phase rotation | The voltages measured are rotating in reverse | |
| MET148-1 fault<br>MET148-2 fault | Hardware problem on an MET module (module 1 or 2) or on an RTD | |
| Watchdog | Monitoring of Sepam operation | Always on O4 if used |
| **"Logic inputs" button** | | |
| Logic inputs I11 to I14 | According to configuration | If MES114 module is configured |
| Logic inputs I21 to I26 | According to configuration | If MES114 is configured |
| **"Equations" button** | | |
| V1 to V10 | Logical equation editor outputs | |

# Logic equations

## Application

This function may be used to configure simple logic functions by combining data received from the protection functions or logic inputs.
By using logic operators (AND, OR, XOR, NOT) and time delays, new processing operations and indications may be added to the existing ones.
The logic functions produce outputs that may be used:
- in the matrix to control relay outputs, light up LEDs or display new messages
- in the protection functions to create new inhibition or reset conditions, for example
- in circuit breaker control to add cases of circuit breaker tripping, closing or inhibition
- in disturbance recording to record particular logic data.




*Logical equation editor.*

## Logic function configuration

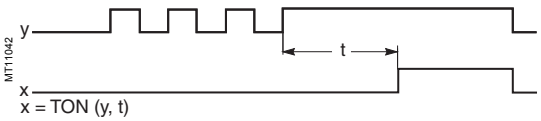
Logical functions are entered in text format in the SFT2841 editor. Each line includes a logic operation, the result of which is assigned to a variable.
Example:
V1 = P5051_2_3 OR I12
The lines are executed sequentially every 14 ms.

## Description of operations

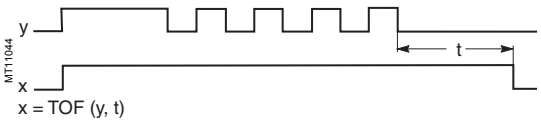
**Operators**
- **NOT**: logic inversion
- **OR**: logic OR
- **AND**: logic AND
- **XOR**: exclusive OR. **V1 XOR V2** is equivalent to **(V1 AND (NOT V2)) OR (V2 AND (NOT V1))**
- **=**: assignment of a result
- //: start of a comment, the characters on the right are not processed
- **(,)**: the operations may be grouped between brackets.

**Functions**
- x **= SR**(y, z): bistable with priority given to Set
  - x is set to 1 when y is equal to 1
  - x is set to 0 when z is equal to 1 (and y is equal to 0)
  - x is unchanged in the other cases.
- **LATCH**(x, y, ...): latching of variables x, y, ...

The variables are maintained constantly at 1 after having been set to 1 a first time. They are reset to 0 after Sepam is recharging ( reset key, external input or remote control order).
The LATCH function accepts as many parameters as the number of variables that the user wishes to latch.
It applies to the entire program, whatever the position in the program. For easier reading, it is advisable to put it at the start of the program.




■ **x = TON**(y, t): on delay timer
The x variable follows the switching to 1 of the y variable with a delay t (t in ms).




■ x **= TOF**(y, t): off delay timer
The x variable follows the switching to 0 of the y variable with a delay t (t in ms).

■ x **= PULSE**(d, i, n): time-tagger
Used to generate n periodic pulses, separated by a time interval i as of the starting time d
□ d is expressed as hour:minute:second
□ i is expressed as hour:minute:second
□ n is an integer (n = -1: repetition until the end of the day).
Example V1 = PULSE (8:30:00, 1:0:0,4) will generate 4 pulses at one-hour intervals at 8 h 30, 9 h 30, 10 h 30, 11 h 30. This will be repeated every 24 hours.
The pulses last for a 14 ms cycle. V1 has the value of 1 during the cycle.
If necessary, V1 may be extended using the **TOF, SR** or **LATCH** functions.

**Maximum number of functions:**
■ the total number of delay timers (TON and TOF) and time-taggers (PULSE) taken together cannot exceed 16
■ there is no limit on the number of bistable (SR) and latching (LATCH) functions.

**Input variables**
They come from protection functions or logic inputs. They may only appear on the right of the assignment sign:
■ **I11** to **I14**, **I21** to **I26**: logic inputs
■ **P**protection_unit_data: a protection output.
Example: **P50**/**51_2_1**, overcurrent protection, unit 2, data 1: time-delayed output.
The data numbers are detailed in the table which follows.

**Output variables**
They are directed to the matrix, or to the protection functions, or to the program logic functions. They may only appear on the left of the assignment sign:
The output variables should only be used once; otherwise the last assignment is taken into account.
■ outputs to the matrix: **V1** to **V10**
The outputs are included in the matrix and may therefore control signal lamps, relay outputs or messages.
■ outputs to a protection input: **P**protection_unit_data
Example: **P59_1_113**, overvoltage protection, unit 1, data 113: protection inhibition.
The data numbers are detailed in the table which follows.
■ outputs to program logic:
□ **V_TRIPCB**: circuit breaker tripping by the circuit breaker control function. Used to complete circuit breaker tripping conditions and activate the recloser.
□ **V_CLOSECB**: circuit breaker closing by the circuit breaker control function. Used to generate a circuit breaker close order based on a particular condition.
□ **V_INHIBCLOSE**: inhibition of circuit breaker closing by the circuit breaker control function. Used to add circuit breaker closing inhibition conditions.
□ **V_FLAGREC**: data saved in disturbance recording. Used to save a specific logical status in addition to those already present in disturbance recording.

**Local variables**
Variables designed for intermediary calculations. They are not available outside the logic equation editor. They may appear on the left or right of the assignment sign.
There are 31 of them: **VL1** to **VL31.**
Two constants are also predefined: **K_1** always equal to 1 and **K_0** always equal to 0.

**Details of protection inputs/outputs**

The tables below list the input/output data available for each protection function. The SFT2841 software includes a data input assistance tool which may be used to quickly identify each data item:

- numbers less than 100 correspond to the protection outputs that may be used as equation input variables
- numbers between 100 and 199 correspond to the protection inputs that may be used as equation output variables
- numbers greater than 200 correspond to the recloser outputs that may be used as equation input variables.

**Table of protection function input and output variables**

| Designation | Bit | 21FL | 27/27S | 27D | 27R | 32P | 32Q | 37 | 38/49T | 46 | 46BC | 47 | 48/51 LR | 49 RMS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Outputs** | | | | | | | | | | | | | | |
| Instantaneous output (pick-up) | **1** | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | | |
| Protection output (time-delayed) | **3** | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Drop-out | **4** | | | | | | | | | | | | | |
| Instantaneous output inverse zone | **6** | | | | | | | | | | | | | |
| Phase 1 fault | **7** | | ■ (1) | | | | | | | | | | | |
| Phase 2 fault | **8** | | ■ (1) | | | | | | | | | | | |
| Phase 3 fault | **9** | | ■ (1) | | | | | | | | | | | |
| Alarm | **10** | | | | | | | | ■ | | | | | ■ |
| Inhibit closing | **11** | | | | | | | | | | | | | ■ |
| RTD fault | **12** | | | | | | | | ■ | | | | | |
| Locked rotor | **13** | | | | | | | | | | | | ■ | |
| Excessive starting time | **14** | | | | | | | | | | | | ■ | |
| Locked rotor at startup | **15** | | | | | | | | | | | | ■ | |
| Protection inhibited | **16** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Hot state | **18** | | | | | | | | | | | | | ■ |
| Positive active power | **19** | | | | | ■ | | | | | | | | |
| Negative active power | **20** | | | | | ■ | | | | | | | | |
| Instantaneous output at 0.8 Is | **21** | | | | | | | | | | | | | |
| Starting in progress | **22** | | | | | | | | | | | | ■ | |
| Recloser in service | **201** | | | | | | | | | | | | | |
| Recloser ready | **202** | | | | | | | | | | | | | |
| Reclosing successful | **203** | | | | | | | | | | | | | |
| Permanent trip | **204** | | | | | | | | | | | | | |
| Reclosing cycle 1 | **211** | | | | | | | | | | | | | |
| Reclosing cycle 2 | **212** | | | | | | | | | | | | | |
| Reclosing cycle 3 | **213** | | | | | | | | | | | | | |
| Reclosing cycle 4 | **214** | | | | | | | | | | | | | |
| **Inputs** | | | | | | | | | | | | | | |
| Reset | **101** | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| VT fault | **103** | | | | | | | | | | | | | |
| Start 50BF | **107** | | | | | | | | | | | | | |
| Inhibition | **113** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Closed circuit breaker | **119** | | | | | | | | | | | | | |
| Downstream load start up | **120** | | | | | | | | | | | | | |

***(1)** When the protection is used with phase-to-neutral voltage.*

**Table of protection function input and output variables (continued)**

| Designation | Bit | 50/51 | CLPU 50/51 | 50BF | 50N/ 51N | CLPU 50N/51N | 51V | 59 | 59N | 66 | 67 | 67N | 79 | 81H | 81L | CT | VT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Outputs** | | | | | | | | | | | | | | | | | |
| Instantaneous output (pick-up) | **1** | ■ | | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | | ■ | ■ | | |
| Protection output (time-delayed) | **3** | ■ | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| Drop-out | **4** | ■ | | | ■ | | ■ | | | | ■ | ■ | | | | | |
| Instantaneous output inverse zone | **6** | | | | | | | | | | ■ | ■ | | | | | |
| Phase 1 fault | **7** | ■ | | | | | ■ | ■ (1) | | | ■ | | | | | ■ | |
| Phase 2 fault | **8** | ■ | | | | | ■ | ■ (1) | | | ■ | | | | | ■ | |
| Phase 3 fault | **9** | ■ | | | | | ■ | ■ (1) | | | ■ | | | | | ■ | |
| Alarm | **10** | | | | | | | | | | | | | | | | |
| Inhibit closing | **11** | | | | | | | | | | | | | | | | |
| RTD fault | **12** | | | | | | | | | | | | | | | | |
| Locked rotor | **13** | | | | | | | | | | | | | | | | |
| Excessive starting time | **14** | | | | | | | | | | | | | | | | |
| Locked rotor at startup | **15** | | | | | | | | | | | | | | | | |
| Protection inhibited | **16** | ■ | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| Hot state | **18** | | | | | | | | | | | | | | | | |
| Positive active power | **19** | | | | | | | | | | | | | | | | |
| Negative active power | **20** | | | | | | | | | | | | | | | | |
| Instantaneous output at 0.8 Is | **21** | | | | | | | | | | ■ | | | | | | |
| Starting in progress | **22** | | | | | | | | | | | | | | | | |
| Recloser in service | **201** | | | | | | | | | | | | ■ | | | | |
| Recloser ready | **202** | | | | | | | | | | | | ■ | | | | |
| Reclosing successful | **203** | | | | | | | | | | | | ■ | | | | |
| Permanent trip | **204** | | | | | | | | | | | | ■ | | | | |
| Reclosing cycle 1 | **211** | | | | | | | | | | | | ■ | | | | |
| Reclosing cycle 2 | **212** | | | | | | | | | | | | ■ | | | | |
| Reclosing cycle 3 | **213** | | | | | | | | | | | | ■ | | | | |
| Reclosing cycle 4 | **214** | | | | | | | | | | | | ■ | | | | |
| **Inputs** | | | | | | | | | | | | | | | | | |
| Reset | **101** | ■ | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| VT fault | **103** | | | | | | | | | | | | | | | | ■ |
| Start 50BF | **107** | | | ■ | | | | | | | | | | | | | |
| Inhibition | **113** | ■ | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Closed circuit breaker | **119** | | | ■ | | | | | | | | | | | | | |
| Downstream load start up | **120** | | ■ | | | ■ | | | | | | | | | | | |

***(1)*** *When the protection is used with phase-to-neutral voltage.*

**Processing upon loss of auxiliary voltage**
The **V1** to **V10, VL1** to **VL 31** and **V_TRIPCB, V_CLOSECB, V_INHIBCLOSE, V_FLAGREC** variables are saved in the event of a Sepam auxiliary power outage. The status is restored when the power returns, allowing the statuses produced by **LATCH**, **SR** or **PULSE** type memory operators to be saved.

**Special cases**
■ brackets must be used in expressions which comprise different **OR, AND, XOR or NOT** operators:
□ **V1 = VL1 AND I12 OR P27/27S_1_1.** // incorrect expression
□ **V1 = (VL1 AND I12) OR P27/27S_1_1.** // correct expression
□ **V1 = VL1 OR I12 OR P27/27S_1_1.** // correct expression
■ only the **V1 to V10, VL1 to VL31 and V_TRIPCB, V_CLOSECB, V_INHIBCLOSE, V_FLAGREC** variables are allowed in the **LATCH** function
■ function parameters cannot be expressions:
□ **VL3 = TON ((V1 AND V3), 300)** // incorrect expression
□ **VL4 = V1 AND V3**
□ **VL3 = TON (VL4, 300)** // correct.

**Use limit**
The number of operators and functions (**OR, AND, XOR, NOT, =, TON, TOF, SR, PULSE**) is limited to 100.

## Examples of applications

■ **latching of recloser final trip data**
By default, this data is of the impulse type at the recloser output. If required by operating conditions, it may be latched as follows:
**LATCH (V1)** // **V1** may be latched
**V1 = P79_1_204** // recloser "final trip" output.
V1 may then control a signal lamp or relay output in the matrix.
■ latching of a signal lamp without latching the protection function
Certain operating conditions call for the latching of indications on the front panel of Sepam, without latching of the trip output O1.
LATCH (V1, V2)
**V1 = P50/51_1_1 OR P50/51_3_1** // tripping, units 1 and 3 of protection 50/51
**V2 = P50/51_2_1 OR P50/51_4_1** // tripping, units 2 and 4 of protection 50/51
V1 and V2 must be configured in the matrix to control 2 front panel signal lamps.
■ circuit breaker tripping if input I13 is present for more than 300 ms.
**V_TRIPCB = TON (I13, 300)**.
■ life line mode (example 1)
If work is underway with the power on (indicated by input I25), and the user wishes to change the relay behavior as follows:
1 - circuit breaker tripping by the instantaneous outputs of protection functions 50/51, unit 1 or 50N/51N, unit 1 AND if input I25 is present:
2 - Recloser inhibition:
**P79_1_113 = I25**
■ life line mode (example 2)
The user wishes to inhibit protection functions 50N/51N and 46 by an input I24:
**P50N/51N_1_113 = I24**
**P46_1_113 = I24**
■ validation of a 50N/51N protection function by logic input I21
An 50N/51N protection function set with a very low set point must only trigger tripping of the circuit breaker if it is validated by an input. The input comes from a relay which accurately measures the current in the neutral point:
**V_TRIPCB = P50N/51N_1_3 AND I21**
■ inhibition of circuit breaker closing if thermal alarm set points are overrun
The temperature protection function 38/49T supplies 16 alarm bits. If one of the first three bits is activated the user wishes to inhibit circuit breaker closing:
**V_INHIBCLOSE = P38/49T_1_10 OR P38/49T_2_10 OR P38/49T_3_10.**

# Self-tests and fail-safe position

## Presentation

The reliability of a device is the property that allows its users to have well-placed confidence in the service it delivers.

For a Sepam protection relay, operational reliability consists of ensuring the safety and availability of the installation. This means avoiding the following 2 situations:

- Nuisance tripping of the protection

Continuity of the electrical power supply is as vital for a manufacturer as it is for an electricity distribution company. Nuisance tripping caused by the protection can result in considerable financial losses. This situation affects the availability of the installation.

- Failure of the protection to trip

The consequences of a fault that is not eliminated can be catastrophic. For safety of operation, the protection relay must detect faults in the power supply as quickly as possible, using discrimination. This situation affects the safety of the installation.

## Self-tests and monitoring functions

On initialization and cyclically during operation, Sepam runs a series of self-tests. These self-tests are designed to detect any failure in its internal and external circuits so as to ensure Sepam's reliability. These failures are classified into 2 categories, major failures and minor failures:

- A major failure reaches the hardware resources used by the protection functions (program memory and analog input for example).

This type of failure risks resulting in failure to trip on a fault or nuisance tripping. In this case, Sepam must go into the fail-safe position as quickly as possible.

- A minor failure affects Sepam's peripheral functions (display, communication).

This type of failure does not prevent Sepam from protecting the installation and providing continuity of service. Sepam then operates in downgraded mode.

The classification of failures into 2 categories improves both safety and availability of the installation.

The possibility of a Sepam major failure must be taken into account when selecting the trip command type to maximize availability or safety of the installation (see "Selecting the trip command and examples of use" page 138).

In addition to the self-tests, the user can activate monitoring functions to improve the installation monitoring:

- VT supervision (ANSI code 60FL)
- CT supervision (ANSI code 60)
- Trip circuit and closing circuit supervision (ANSI code 74)

These functions send an alarm message to the Sepam display unit and a data item is automatically available to the communication to alert the user.

## Self-tests

The self-tests are run when Sepam is initialized and/or during its operation.

### List of self-tests which place Sepam in the fail-safe position

Failures which have caused this are deemed to be major ones.

| Function | Test type | Execution period |
|---|---|---|
| **Power supply** | | |
| | Power supply presence | During operation |
| **CPU** | | |
| | Processor | On initialization and during operation |
| | RAM memories | On initialization and during operation |
| **Program memory** | | |
| | Checksum | On initialization and during operation |
| **Parameter memory** | | |
| | Checksum | On initialization |
| **Analog inputs** | | |
| | Current | During operation |
| | Voltage | During operation |
| **Logic outputs** | | |
| | Relay driver | On initialization and during operation |
| **Connection** | | |
| | CCA630, CCA634, CCA670 | On initialization and during operation |
| | MES114 | On initialization and during operation |

### List of self-tests which do not place Sepam in the fail-safe position

Failures which have caused this are deemed to be minor ones.

| Function | Test type | Execution period |
|---|---|---|
| **UMI** | | |
| | Module presence | On initialization and during operation |
| **Analog output** | | |
| | Module presence | On initialization and during operation |
| **Temperature inputs** | | |
| | Module presence | On initialization and during operation |

# Self-tests and fail-safe position

## Fail-safe position

When Sepam is in working order, it runs self-tests continuously. Detection of a major failure places Sepam in the fail-safe position.

### State of Sepam in the fail-safe position

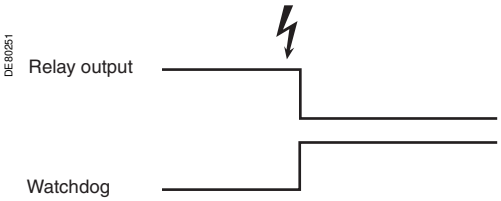
- All the output relays are forced to the idle state
- All protection functions are inhibited
- The watchdog output indicates failure (output in the idle state)
- A red LED on the Sepam front panel is on and a diagnostic message appears on the Sepam display unit (see "Local indication ANSI code 30", page 127).

### How Sepam deals with failures

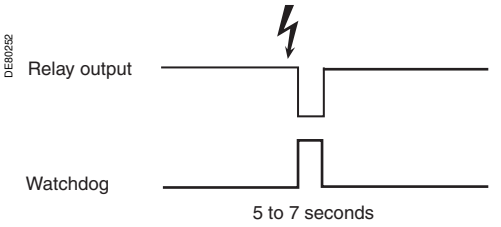
- Minor failure: Sepam switches to downgraded operation.

The failure is indicated on the Sepam display unit and also by the communication. Sepam continues to protect the installation.

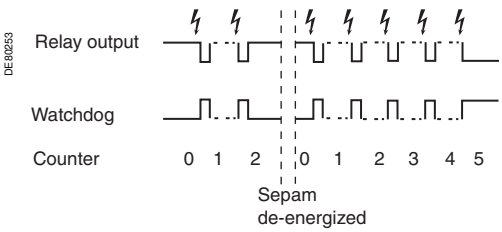
- Major failure: Sepam switches to the fail-safe position and attempts a restart during which it again runs its self-tests. There are 2 possible scenarios:
  - The internal failure is still present. It is a permanent failure. Intervention on Sepam is required. Only removing the cause of the failure, followed by de-energizing and then energizing Sepam, will allow the unit to exit the fail-safe position.
  - The internal failure is no longer present. It is a transient failure. Sepam restarts so that it can continue to protect the installation. Sepam has been in the fail-safe position for 5 to 7 s.




*Permanent internal failure.*




*Transient internal failure.*




*Repeated transient internal failures.*

### Limiting the number of transient failure detections

Each time a transient internal failure appears, Sepam increments an internal counter. The fifth time the failure occurs, Sepam is placed in the fail-safe position.
De-energizing Sepam reinitializes the failure counter. This mechanism can be used to avoid keeping a Sepam running that is subject to repeated transient failures.

## Selecting the trip command and examples of use

An analysis of the operational reliability of the whole installation should determine whether availability or safety of this installation should be prioritized if Sepam is in the fail-safe position. This information is used to determine the choice of trip command as outlined in the table below.

**CAUTION**

**RISK OF UNPROTECTED INSTALLATION**

Always connect the watchdog output to a monitoring device when the selected trip command does not result in the installation tripping when Sepam fails.

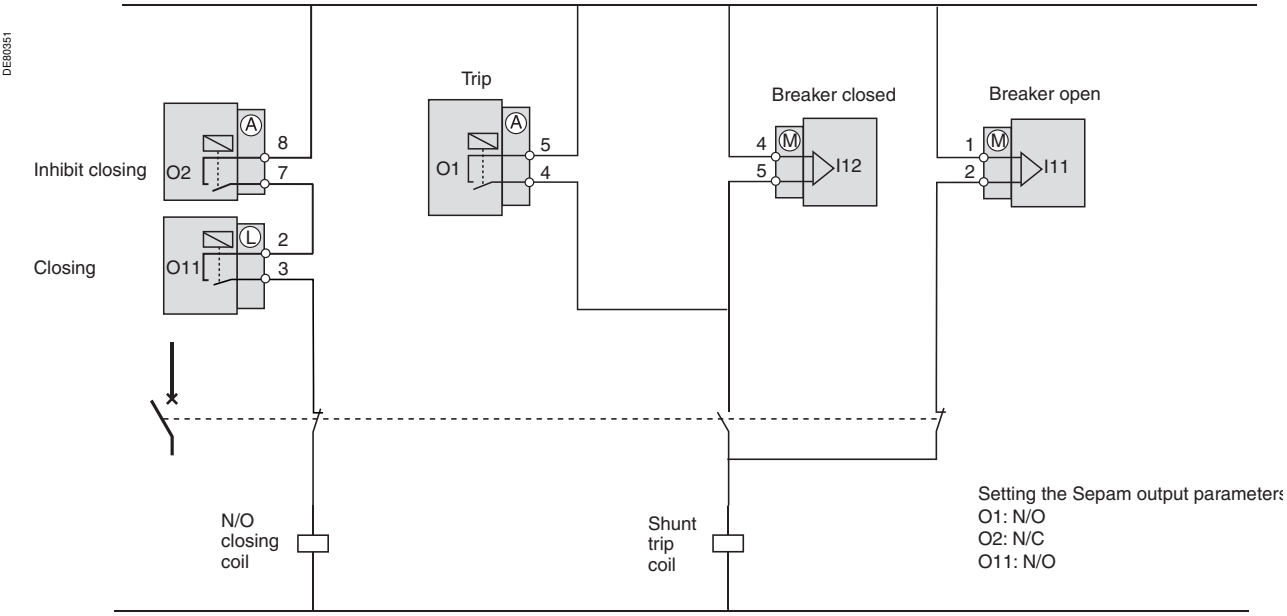
**Failure to follow these instructions can result in equipment damage.**

### Selecting the trip command

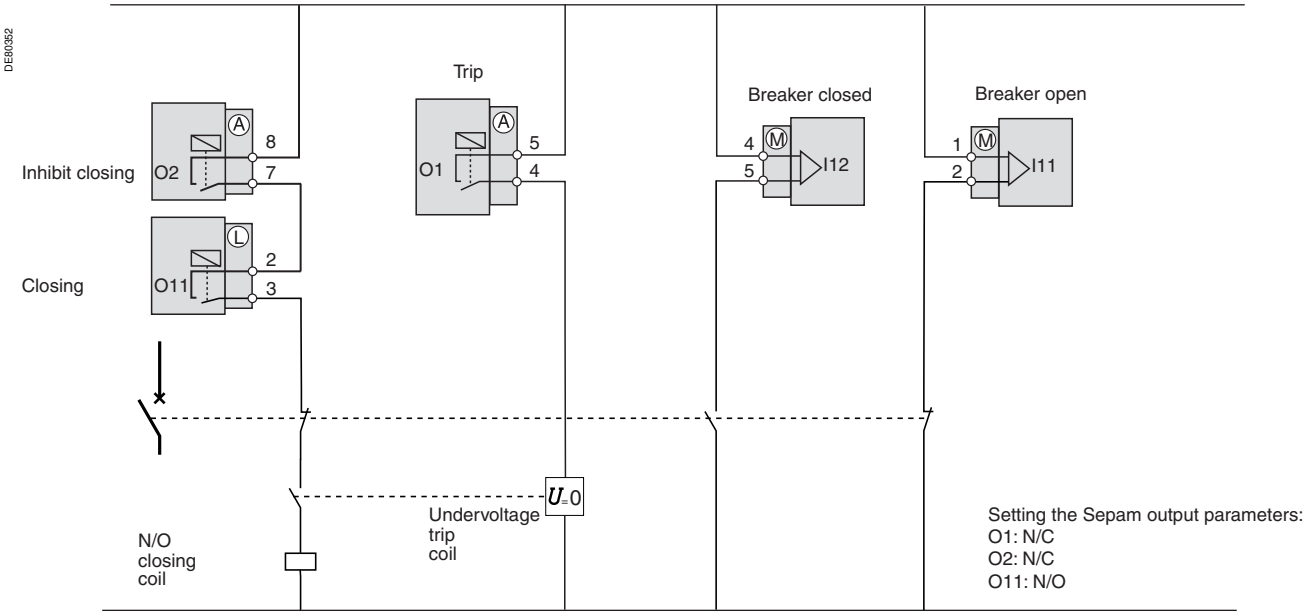
| Diagram | Control | Event | Trip | Advantage | Disadvantage |
|---|---|---|---|---|---|
| 1 | Shunt trip breaker or mechanical latching contactor | Sepam failure or loss of the auxiliary power supply | No | Availability of the installation | Installation not protected until remedial intervention (1) |
| 2 | Breaker with undervoltage trip coil (fail-safe) | Sepam failure or loss of the auxiliary power supply | Yes | Safety of the installation | Installation not available until remedial intervention |
| 3 | Breaker with undervoltage trip coil (not fail-safe) | Sepam failure | No | Availability of the installation | Installation not protected until remedial intervention (1) |
| | | Loss of auxiliary power supply | Yes | Safety of the installation | Installation not available until remedial intervention |

***(1)** It is essential to use the watchdog, see the warning notice opposite.*

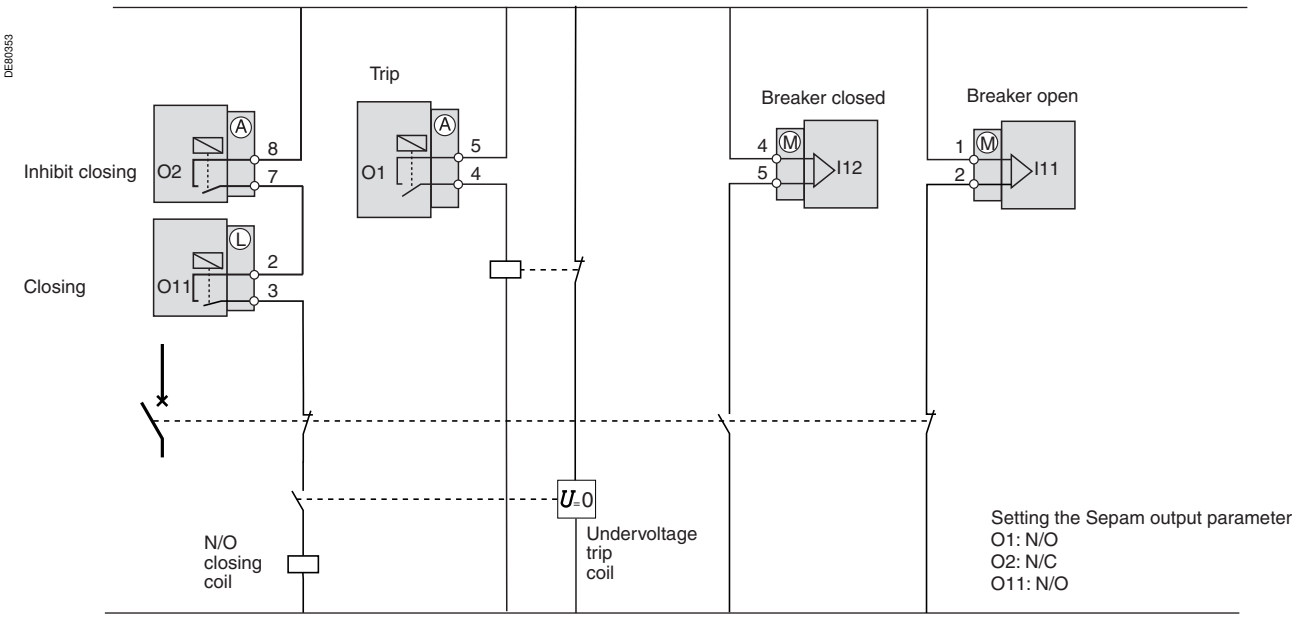
### Example of use with shunt trip coil (diagram 1)



**Example of use with undervoltage trip coil with fail-safe condition (diagram 2)**




**Example of use with undervoltage trip coil without fail-safe condition (diagram 3)**



## Using the watchdog

The watchdog is extremely important in the monitoring system, as it indicates to the user that the Sepam protection functions are working correctly. When Sepam detects an internal failure, a LED flashes automatically on the Sepam front panel regardless of whether the watchdog output is connected correctly. If the watchdog output is not correctly connected to the system, this LED is the only way of knowing that Sepam has failed. We therefore strongly recommend connecting the watchdog output at the highest level of the installation so that an effective alarm is generated when necessary. For example, an audible alarm or flashing alarm lamp can be used to warn the operator.

| Watchdog output status | No failure detected | Failure detected |
|---|---|---|
| Watchdog output connected correctly to the control system | The protection functions are in working order | ■ The protection functions are not working.<br>■ Sepam is in the fail-safe position.<br>■ The Sepam alarm LED flashes.<br>■ The watchdog output activates a system alarm.<br>■ The operator is warned that he needs to intervene. |
| Watchdog output not connected | The protection functions are in working order | ■ The protection functions are not working.<br>■ Sepam is in the fail-safe position.<br>■ The Sepam alarm LED flashes.<br>■ The need of maintenance is detected only if an operator controls the front panel of the digital relay. |

# Contents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# Presentation

## General

Modbus communication allows Sepam to be connected to a supervisor or any other device with a master Modbus communication channel.
Sepam is always a slave station.

Sepam is connected to a Modbus communication network via a communication interface.
There is a choice of 3 types of communication interface:
- Communication interfaces to connect Sepam to a single serial network:
  - ACE949-2, for connection to a 2-wire RS 485 network
  - ACE959, for connection to a 4-wire RS 485 network
  - ACE937, for connection to a fiber-optic star network.
- Communication interfaces to connect Sepam to two serial networks:
  - ACE969TP-2, for connection to:
    - one 2-wire RS 485 Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network
  - ACE969FO-2, for connection to:
    - one fiber-optic Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network.
- Communication interfaces to connect Sepam to an Ethernet network:
  - ACE850TP for electrical connection to the network
  - ACE850FO for optical connection to the network

## Data available

The data available depend on the type of Sepam.

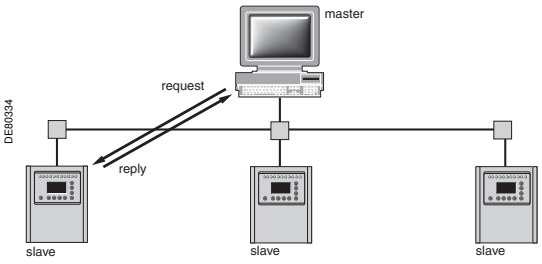
**Measurement readout**
- phase and earth fault currents
- peak demand phase currents
- tripping currents
- cumulative breaking current
- phase-to-phase, phase-to-neutral and residual voltages
- active, reactive and apparent power
- active and reactive energy
- frequency
- temperatures
- thermal capacity used
- starts per hour and inhibit time
- running hours counter
- motor starting current and time
- operating time before overload tripping
- waiting time after tripping
- operating time and number of operations
- circuit breaker charging time.

**Program logic data readout**
- a table of 144 pre-assigned remote indications (TS) (depends on the type of Sepam) enables the readout of program logic data status
- readout of the status of 10 logic inputs.

**Remote control orders**
Writing of 16 impulse-type remote control orders (TC) in either direct mode or SBO (Select Before Operate) mode via 16 selection bits.

**Other functions**
- reading of Sepam configuration and identification
- time-tagging of events (synchronization via the network or externally via logic input I21), time-tagging within a millisecond
- remote reading of Sepam settings
- remote setting of protection units
- remote control of the analog output (with MSA141 option)
- transfer of disturbance recording data.

# Modbus protocol
## Presentation




### Exchanges
The Modbus protocol exchanges information using a request-reply mechanism between a master and a slave.
An exchange is always initiated (request sent) by the master. The only action on the part of a slave is to reply to requests received.
Where the communication network permits, several slaves units can be connected to a single master. A request contains the slave address (a unique number) to identify the recipient. Non-addressed slaves disregard the requests received.

### Modbus Protocol Data Unit
Every Modbus request or response frame includes a Modbus PDU (protocol data unit) made up of 2 fields.

| Function code | Data |
|---|---|

- function code (1 byte): indicates the type of request (1 to 127)
- data (0 to n bytes): depends on the function code, see below.

If there is no error, the function codes in the reply and in the request are identical.

### Modbus data types
Modbus uses 2 types of data: bits and 16-bit words (also called registers).
Each element of data is identified by a 16-bit address.
The most-significant byte in 16-bit words is always sent first, for both data and addresses.

### Modbus functions supported
The Modbus protocol used by Sepam is a compatible sub-group of the RTU Modbus protocol.
The functions listed below are handled by Sepam:
- basic functions (data access)
  - function 1: reading of n output or internal bits
  - function 2: reading of n input bits
  - function 3: reading of n output or internal words
  - function 4: reading of n input words
  - function 5: writing of 1 bit
  - function 6: writing of 1 word
  - function 7: high-speed reading of 8 bits
  - function 15: writing of n bits
  - function 16: writing of n words.
- communication-management functions:
  - function 8: Modbus diagnosis
  - function 11: reading of Modbus event counter
  - function 43: sub-function 14: reading of identification

The following exception codes are supported:
- 1: unknown function code
- 2: incorrect address
- 3: incorrect data
- 4: not ready (cannot process request)
- 7: not acknowledged (remote reading and setting).

### Modbus specification
The full description of the Modbus protocol can be found at www.modbus.org.

# Modbus protocol
## Serial line Modbus

This description is limited to the Modbus protocol using a serial link in binary mode (RTU mode).

### Frames

All the frames exchanged have the same structure, made up of 3 parts.

| Slave address | Modbus PDU | Check (CRC16) |
|---|---|---|

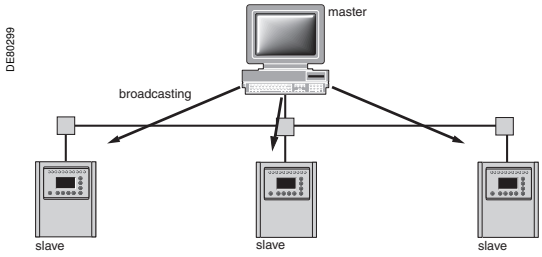
- Slave address (1 byte): from 1 to 247 (0 for broadcasting)
- Modbus PDU: as previously described
- Check (2 bytes): CRC16 used to check frame integrity.

The slave addresses in the reply and in the request are identical.
The maximum size of a frame is 256 bytes (255 for Sepam series 40).

### Synchronization of exchanges

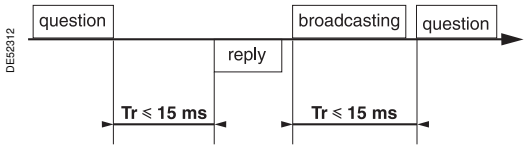
Any character that is received after a silence of more than 3.5 characters is considered as the beginning of a new frame. A minimum silence of 3.5 characters must always be observed between two frames.
A slave disregards all frames:

- received with a physical error for 1 or more characters (format error, parity error, etc.)
- with an incorrect CRC16 result
- for which it is not the recipient.




### Broadcasting

The master can also address all slaves using the conventional address 0. This type of exchange is called broadcasting.
Slaves do not respond to broadcast messages. As a result, only messages that do not require the transmission of data by the slaves can be broadcast.




### Response time

The communication coupler **response time (Tr)** is less than 15 ms, including a 3-character silence (approximately 3 ms at 9600 bauds).
This time is given with the following parameters:

- 9600 bauds
- format: 8 bits, odd parity, 1 stop bit.

# Modbus protocol
## Modbus over TCP/IP

Requests and replies are exchanged as TCP/IP messages over a TCP connection. The slave address is therefore its IP address.

### Frames

The application layer part of a Modbus/TCP frame is made up of 2 fields:

| MBAP Header | Modbus PDU |
|---|---|

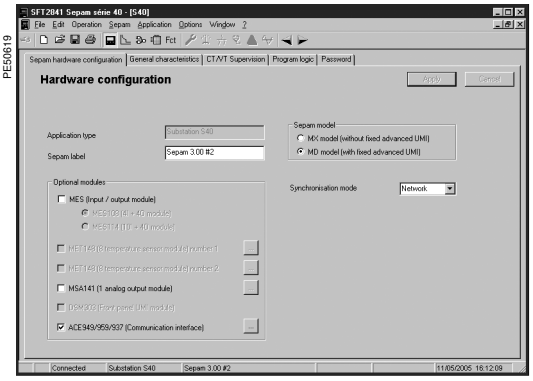
- MBAP (Modbus Application) Header (7 bytes): identifies the frame
- Modbus PDU: as previously described.

### Modbus Application header

It contains the following fields:

| Field | Length | Description | Request | Response |
|---|---|---|---|---|
| Transaction identifier | 2 bytes | Identification of a Modbus request/ response transaction | Field initialized by the client | Field copied by the server from the received request |
| Protocol identifier | 2 bytes | 0 = Modbus protocol | Field initialized by the client | Field copied by the server from the received request |
| Length | 2 bytes | Number of following bytes (including unit identifier) | Field initialized by the client | Field initialized by the server |
| Unit identifier | 1 byte | In case of gateways, identifies a remote slave device connected on a serial line. Should be 255 in other cases. | Field initialized by the client | Field copied by the server from the received request |

# Configuring the communication interfaces
## Serial line communication



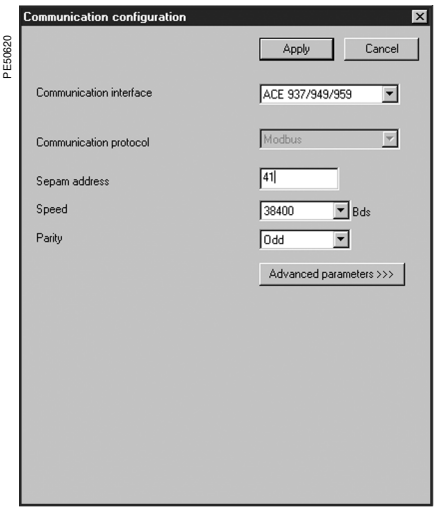

*SFT2841: Sepam Configuration screen.*

### Access to configuration parameters

The Sepam communication interfaces are configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in SFT2841.
To access this window:
- open the **Sepam configuration** window in SFT2841
- check the box for ACExxx (communication interface)
- click [...]: the **Communication configuration** window appears
- select the type of interface used: ACE949/ACE959/ACE937, ACE969TP or ACE969FO
- select the Modbus communication protocol.

The configuration parameters will vary depending on the communication interface selected: ACE949/ACE959/ACE937, ACE969TP or ACE969FO. The table below specifies the parameters to be configured depending on the communication interface chosen.

| Parameters to be configured | ACE949<br>ACE959<br>ACE937 | ACE969TP | ACE969FO |
|---|---|---|---|
| Physical layer parameters | ■ | ■ | ■ |
| Fiber-optic parameters | | | ■ |
| Modbus advanced parameters | ■ | ■ | ■ |
| E-LAN parameters | | ■ | ■ |




*SFT2841: communication configuration window for ACE949.*

### Configuring the physical layer of the Modbus port

Asynchronous serial transmission is used with the following character format:
- 1 start bit
- 8 data bits
- 1 stop bit
- parity according to parameter setting.

The number of stop bits is always set at 1.
If a configuration with parity is selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.
If a no parity configuration is selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit.

The configuration parameters for the physical layer of the Modbus port are:
- slave number (Sepam address)
- transmission speed
- parity check type.

| Parameters | Authorized values | Default value |
|---|---|---|
| Sepam address | 1 to 247 | 1 |
| Speed | 4800, 9600, 19200 or 38400 bauds | 19200 bauds |
| Parity | None, Even or Odd | Even |

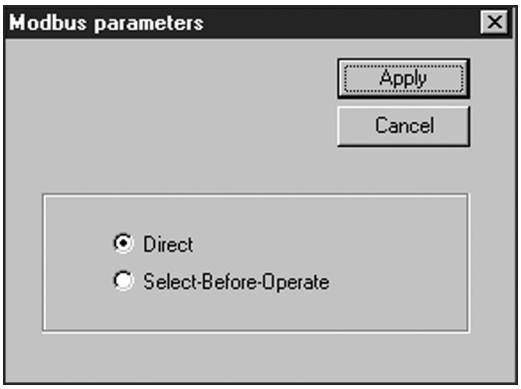
### Configuring the ACE969FO-2 fiber-optic port

The configuration for the physical layer of the ACE969FO-2 fiber-optic port is completed with the following 2 parameters:
- Link idle state: light-on or light-off
- Echo mode: with or without.

| Fiber-optic parameters | Authorized values | Default value |
|---|---|---|
| Link idle state | Light Off or Light On | Light Off |
| Echo mode | Yes (fiber-optic ring)<br>or No (fiber-optic star) | No |

***Note:*** *in echo mode, the Modbus master will receive the echo of its own request before the slave's reply. The Modbus master must be able to disregard this echo. Otherwise, it is impossible to create a Modbus fiber-optic ring.*

# Configuring the communication interfaces
## Serial line communication

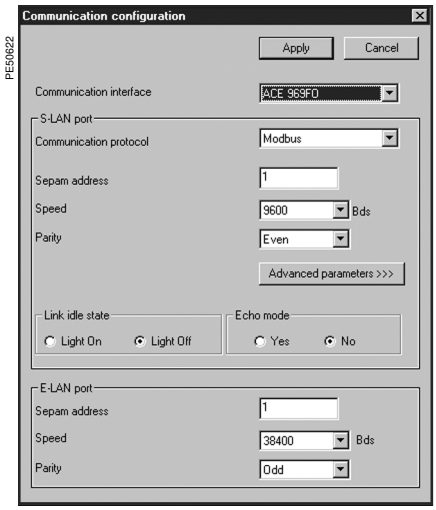



*SFT2841: Modbus advanced parameters window.*

### Configuring Modbus advanced parameters

The Sepam remote control mode is selected from the Advanced parameters window.

| Advanced parameters | Authorized values | Default value |
|---|---|---|
| Remote control mode | Direct or SBO (Select Before Operate) mode | Direct |




*SFT2841: communication configuration window for ACE969FO.*

### Configuring the physical layer of the ACE969-2 E-LAN port

The E-LAN port on the ACE969TP-2 and ACE969FO-2 communication interfaces is a 2-wire RS 485 port.

The configuration parameters for the physical layer of the E-LAN port are:

- Sepam address
- transmission speed
- parity check type.

The number of stop bits is always set at 1.

If a configuration with parity is selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.

If a no parity configuration is selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit.

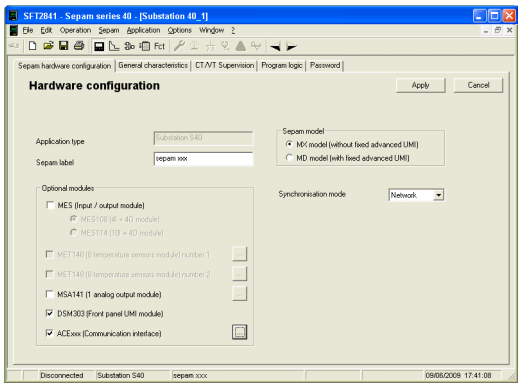
| Parameters | Authorized values | Default value |
|---|---|---|
| Sepam address | 1 to 247 | 1 |
| Speed | 4800, 9600, 19200 or 38400 bauds | 38400 bauds |
| Parity | None, Even or Odd | Odd |

### Configuration tips

- The Sepam address MUST be assigned before Sepam is connected to the communication network.
- You are also strongly advised to set the other physical layer configuration parameters before making the connection to the communication network.
- Modifying the configuration parameters during normal operation will not disturb Sepam but will reset the communication port.

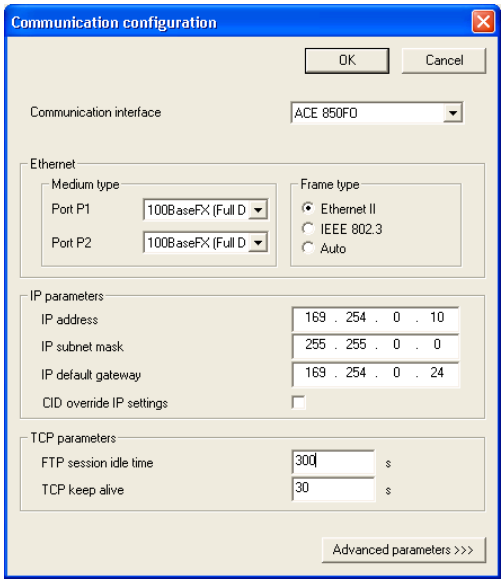
# Configuring the communication interfaces
## Ethernet communication

PE80510




*SFT2841: Sepam configuration screen.*

PE80395




*SFT2841: Ethernet and TCP/IP configuration.*

### Access to configuration parameters

The Sepam communication interfaces must be configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in the SFT2841 software.
To access this window:
- open the **Sepam configuration** window in SFT2841
- check the box for ACExxx (communication interface)
- click on the relevant button [...]: the **Communication configuration** window appears
- select the type of interface used: ACE850TP or ACE850FO.

Configuring an ACE850 involves:
- configuring the standard Ethernet parameters (mandatory)
- configuring one or more of the following sets of advanced optional parameters:
  - SNMP: Ethernet network management
  - SNTP: time synchronization
  - IP filtering: access control
  - RSTP: Ethernet ring management
  - User accounts: access control.

### Ethernet and TCP/IP configuration

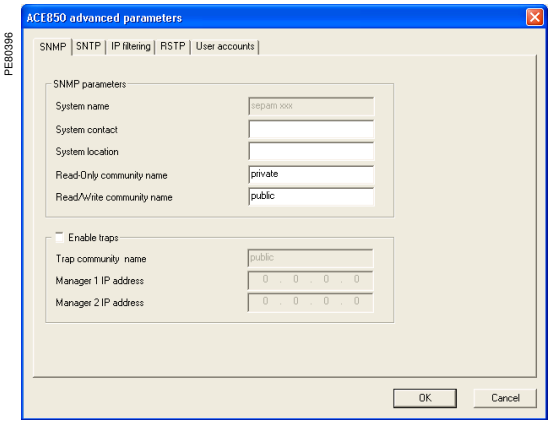
Before configuring the ACE850, obtain a unique static IP address, subnet mask, and default gateway address from the network administrator. See the section on IP address and parameter guidelines, page 151.

| Parameters | Description | Authorized values |
|---|---|---|
| Frame format | Used to select the format for data sent over an Ethernet connection. | Ethernet II, 802.3, Auto<br>**Default**: Ethernet II |
| Media type | Used to define the physical Ethernet connection. | ACE850TP<br>■ 10T/100Tx Auto<br>■ 10BaseT-HD<br>■ 10BaseT-FD<br>■ 100BaseTX-HD<br>■ 100BaseTX-FD<br>**Default**: 10T/100Tx Auto |
| | | ACE850FO<br>■ 100BaseFX-HD<br>■ 100BaseFX-FD<br>**Default**: 100BaseFX-FD |
| IP address | Used to enter the static IP address of the ACE850. | 0.0.0.0 to 255.255.255.255<br>**Default**: 169.254.0.10 |
| Subnet mask | Used to enter the subnet mask of your network. | 0.0.0.0 to 255.255.255.255<br>**Default**: 255.255.0.0 |
| Default gateway | Used to enter the default gateway (router) IP address used for wide area network (WAN) communications. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |
| Allow CID file to override IP parameters | This parameter is not used for Modbus only communication. | **Default**: not checked |
| Keep alive | Timeout value used to test for session disconnection. | 1 to 60 seconds<br>**Default**: 30 seconds |
| FTP session inactivity timeout | Timeout value used to force disconnection of an inactive FTP session | 30 to 900 seconds<br>**Default**: 30 seconds |

#### Duplicate IP address detection

The ACE850 IP address must be unique in the network. If it is not unique, the Status LED repeats a four blink-pause pattern and a new IP address must be assigned to the ACE850 or to the conflicting device.

# Configuring the communication interfaces
## Ethernet communication



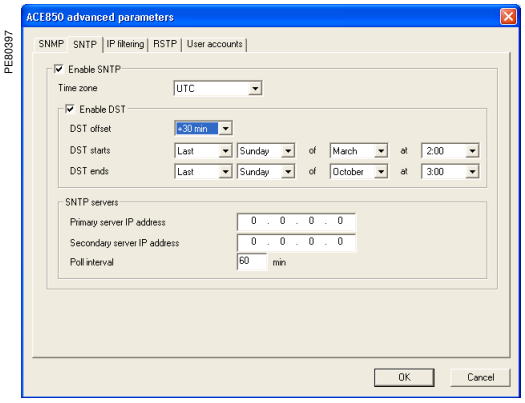

*SFT2841: SNMP configuration.*

### SNMP configuration

The ACE850 supports SNMP V1, allowing a network administrator to remotely access it with an SNMP manager and view the network status and diagnostics in the MIB2 format (only a subset of MIB2 is implemented).
Additionally, the ACE850 may be configured to send SNMP traps in the following cases:

- ACE850 start/restart
- Link up
- Link down
- Authentication failure.

| Parameters | Description | Authorized values |
|---|---|---|
| System Name | This parameter is the same as the Sepam label. | Not modifiable from this screen. |
| System Contact | Name of the administrative contact | String (< 16 characters)<br>**Default**: empty string |
| System Location | Location of the Sepam/ACE850 | String (< 16 characters)<br>**Default**: empty string |
| Read-only Community Name | SNMP community that has read-only access to the MIB. Acts as a password. | String (< 16 characters)<br>**Default**: "public" |
| Read-write Community Name | SNMP community that has read-write access to the MIB. Acts as a password. | String (< 16 characters)<br>**Default**: "private" |
| Enable traps | Checking this check box enables SNMP to send traps. | **Default**: "not checked" |
| Traps Community Name | SNMP community that is used with traps. | String (< 16 characters)<br>**Default**: "public" |
| Manager 1 IP address | IP address of the SNMP manager to which traps are sent. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |
| Manager 2 IP address | IP address of a second SNMP manager to which traps are sent. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |




*SFT2841: SNTP configuration.*

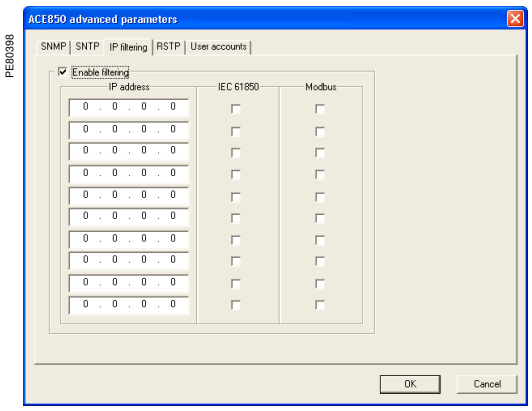
### SNTP configuration

SNTP is a time synchronization protocol that can be used to synchronize the Sepam. SNTP is used in mode 3-4 (unicast mode).

- If SNTP is used, the synchronization source for Sepam must be defined as Ethernet.
- If SNTP is not used, the Sepam synchronization must be ensured by other means (Modbus frames, synchronization tops).

| Parameters | Description | Authorized values |
|---|---|---|
| Enable SNTP | Enables the time and date of the Sepam to be set by the Simple Network Time Protocol (SNTP) server. | **Default**: not enabled |
| Time Zone Offset | Determines the difference between local time and Coordinated Universal Time (UTC) (same as GMT). | UTC-12 to UTC+14<br>**Default**: UTC |
| Enable Daylight Saving Time | Enables the use of Daylight Saving Time (Summer time). | **Default**: not enabled |
| DST offset | Difference between standard time and Daylight Saving Time. | + 30 or + 60 minutes<br>**Default**: + 60 minutes |
| DST starts | If enabled, DST starts on the selected date. | **Default**: last Sunday of March |
| DST ends | If enabled, DST ends on the selected date. | **Default**: last Sunday of October |
| Primary Server IP Address | The IP address of the SNTP server the ACE850 contacts to get the time message. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |
| Secondary Server IP Address | The IP address of another SNTP server the ACE850 contacts in case the primary server is down. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |
| Poll Interval | Controls how often the ACE850 contacts the SNTP server for the correct time. | 1 to 300 minutes<br>**Default**: 60 minutes |

# Configuring the communication interfaces
## Ethernet communication



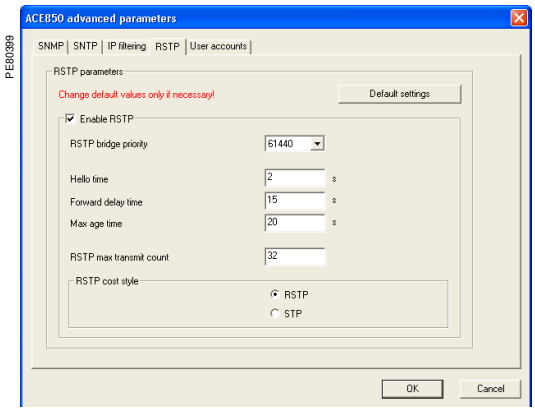

*SFT2841: IP filtering configuration.*

### IP filtering configuration

The IP filtering function allows the administrator to specify which Modbus/TCP clients and which IEC 61850 clients have access to the ACE850 services.

***Note:*** *if IP filtering is enabled, access is forbidden to any client not in the filtered list.*

| Parameters | Description | Authorized values |
|---|---|---|
| Enable filtering | Check this box to activate filtering based on IP addresses. | **Default**: not enabled |
| IP address | The IP address of a client for which filtering options are defined. | 0.0.0.0 to 255.255.255.255<br>**Default**: 0.0.0.0 |
| IEC 61850 | Check this box to grant IEC 61850 access to the given IP address. | **Default**: not checked |
| Modbus | Check this box to grant Modbus/TCP access to the given IP address. | **Default**: not checked |



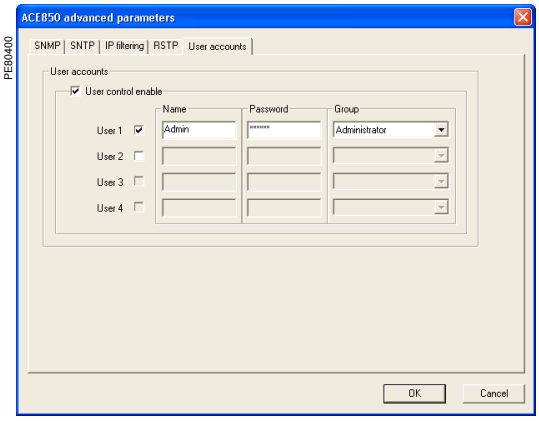

*SFT2841: RSTP configuration.*

### RSTP configuration

The RSTP protocol enables the use of redundant Ethernet architectures such as rings.
It must be enabled each time the ACE850 is included in a loop. It may be disabled in other cases.
Changing the default settings is normally not required and should be performed with extreme care as it could jeopardize the stability of the Ethernet network.
If in doubt, it is always possible to revert to the default values using the Default settings button.

| Parameters | Description | Authorized values |
|---|---|---|
| Enable RSTP | Check this box to activate the use of the RSTP protocol. | **Default**: enabled |
| Bridge priority | Priority of the bridge. The bridge with the lowest priority becomes root. | 0 - 61440, by steps of 4096<br>**Default**: 61440 |
| Hello time | Amount of time between the transmission of configuration messages | 1 to 10 seconds<br>**Default**: 2 seconds |
| Forward delay time | Time value to control how fast a port changes its spanning state when moving towards the forwarding state | 4 to 30 seconds<br>**Default**: 21 seconds |
| Max age time | Valid duration of configuration message once sent by the root bridge | 6 to 40 seconds<br>**Default**: 40 seconds |
| Max transmit count | Maximum BPDUs that can be transmitted by the Port Transmit state machine in any Hello time. This value limits the maximum transmission rate. | 3 to 100<br>**Default**: 32 |
| Cost style | RSTP (32 bits) or STP (16 bits) cost style selection | **Default**: RSTP |

***Note:*** *RSTP parameters must verify the following relationships:*
- *2 x (Forward_delay_time - 1 second) ≥ Max_age_time*
- *Max_age_time ≥ 2 x (Hello_time + 1 second).*




*SFT2841: User accounts configuration.*

## User accounts configuration

ACE850 users are assigned usernames and passwords used to gain access to the FTP or WEB servers. Each user belongs to a group which determines the user's access rights:

- Administrator: read-write access to the FTP server, access to the WEB server
- Operator: read-only access to the FTP server, access to the WEB server
- Guest: no access to the FTP server, access to the WEB server

Up to 4 user accounts can be defined.

| Parameters | Description | Authorized values |
|---|---|---|
| User control enable | Check this box to enable the configuration of users account. Currently, the ACE850 will not operate if this box is not checked. Ensure that this box is always checked. | **Default**: enabled |
| User n | Check this box to create this user account. Uncheck it to delete the account (only the last account in the list can be deleted). | **Default**: user 1 enabled<br>Users 2 to 4 disabled |
| Name | User name | String (1 to 8 characters) |
| Password | User password | String (4 to 8 characters) |
| Group | Group to which the user belongs | Administrator, Operator, Guest |

The following account is always created by default as user 1:

- Name: Admin
- Password: ACE850
- Group: Administrator

## IP address and parameter guidelines

### IP addresses

Several configuration parameters are IP addresses. These addresses must follow precise rules which are enforced by SFT2841 and ACE850. These rules are:

- Every IP address is made of 4 fields separated by dots: x . y . z . t
- Each field is a decimal value coded on 8 bits (range [0..255]).
- The first field (x) must be in the range [1..224] but must not be 127.
- Intermediate fields can cover the full range [0..255].
- The last field must not be 0 (range [1..255]).

### IP subnet mask

The IP subnet mask is also made of 4 dot separated fields:

- The binary representation of the subnet mask is made of a set of 8 to 30 contiguous ones in the most significant part, followed by a set of contiguous zeroes (255.0.0.0 to 255.255.255.252).
- For a class A IP address ($x \leqslant 126$), the number of ones in the subnet mask must be at least 8 (255.y.z.t).
- For a class B IP address ($128 \leqslant x \leqslant 191$), the number of ones in the subnet mask must be at least 16 (255.255.z.t).
- For a class C IP address ($192 \leqslant x \leqslant 223$), the number of ones in the subnet mask must be at least 24 (255.255.255.t).
- The subnet part of the device IP address, obtained when applying the subnet mask, must not be 0.

### IP default gateway

- An IP address of 0.0.0.0 means no gateway.
- If a gateway is defined, it must belong to the same subnet as the device.

## Installing the communication network

**Preliminary study**
The communication network must first be the subject of a technical study to determine the following, according to the installation characteristics and constraints (geography, amount of information processed, etc.):
- the type of medium (electrical or fiber optic)
- the number of Sepam units per network
- the transmission speed
- the ACE interfaces configuration
- the Sepam parameter settings.

**Sepam user manual**
The communication interfaces must be installed and connected in accordance with the instructions in the Installation chapter of this manual.

## Preliminary checks

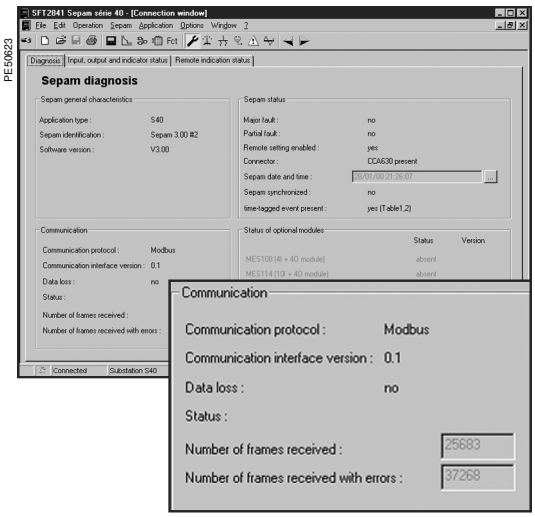
The following preliminary checks must be made:
- check the CCA612 cord connection between the ACE interface and the Sepam base unit
- check the ACE Modbus communication port connection
- check the complete configuration of the ACE
- for the ACE969, check the auxiliary power supply connection.

## Checking the operation of the ACE interface

You can use the following to check that an ACE interface is operating correctly:
- the indicator LEDs on the front panel of the ACE
- the information provided by the SFT2841 software connected to Sepam:
  - on the Diagnosis screen
  - on the Communication configuration screens.

**Link activity LED for ACE949-2, ACE959 and ACE937**
The link activity LED for ACE949-2, ACE959 and ACE937 interfaces flashes when Sepam transmission or reception is active.

**Indicator LEDs on the ACE969**
- green "on" LED: ACE969 energized
- red "key" LED: ACE969 interface status
  - LED off: ACE969 configured and communication operational
  - LED flashing: ACE969 configuration error or ACE969 not configured
  - LED on: ACE969 error
- link activity LED: S-LAN Tx flashing, Sepam transmission active
- link activity LED: S-LAN Rx flashing, Sepam reception active.


PE50623
SFT2841 Sepam série 40 - [Connection window]
Sepam diagnosis
Communication
Communication protocol : Modbus
Communication interface version : 0.1
Data loss : no
Status :
Number of frames received : 25683
Number of frames received with errors : 37268

*SFT2841: Sepam series 40 diagnosis screen.*

## Diagnosis using SFT2841 software

**Sepam diagnosis screen**
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
All Sepam status information appears on the Sepam diagnosis screen.

**Sepam communication diagnosis**
The operator is provided with the following information to assist with identifying and resolving communication problems:
- name of the protocol configured
- Modbus interface version number
- number of valid frames received (CPT9)
- number of invalid (mistaken) frames received (CPT2).

## Link activity LED

The ACE interface link activity LEDs are activated by variations in the signal on the Modbus network. When the supervisor communicates with Sepam (during transmission or reception), these LEDs flash.
After wiring, check the information given by the link activity LEDs when the supervisor operates.

***Note:*** *Flashing indicates that there is traffic passing to or from Sepam; it does not mean that the exchanges are valid.*

## Functional test

If there is any doubt about correct operation of the link:
- run read/write cycles in the test zone
- use Modbus diagnosis function 8 (sub-code 0, echo mode).

The Modbus frames below, transmitted or received by a supervisor, are an example of a test performed when communication is set up.

| **Test zone** | |
|---|---|
| **Read** | |
| Transmission | 01 03 0C00 0002 C75B |
| Reception | 01 03 04 0000 0000 FA33 |
| **Write** | |
| Transmission | 01 10 0C00 0001 02 1234 6727 |
| Reception | 01 10 0C00 0001 0299 |
| **Read** | |
| Transmission | 01 03 0C00 0001 875A |
| Reception | 01 03 02 1234 B533 |
| **Function 8 - Modbus diagnosis, echo mode** | |
| Transmission | 01 08 0000 1234 ED7C |
| Reception | 01 08 0000 1234 ED7C |

Even in echo mode, Sepam recalculates and checks the CRC sent by the master:
- if the CRC received is valid, Sepam replies
- if the CRC received is invalid, Sepam does not reply.

## Modbus diagnosis counters

**Counter definition**

Sepam manages the Modbus diagnosis counters. These are:
- **CPT1**: Number of valid frames received, whether the slave is involved or not
- **CPT2**: Number of frames received with a CRC error or physical error (frames with more than 255 bytes, frames received with at least one parity, overrun, framing or line-break error)
- **CPT3**: Number of exception responses generated (even if not transmitted, due to receipt of a broadcast request)
- **CPT4**: Number of frames specifically addressed to the station (excluding broadcasting)
- **CPT5**: Number of valid broadcast frames received
- **CPT6**: Not significant
- **CPT7**: Not significant
- **CPT8**: Number of frames received with at least one character having a physical error (parity, overrun, framing or line break)
- **CPT9**: Number of valid requests received and correctly executed.

**Counter reset**

The counters are reset to 0:
- when they reach the maximum value FFFFh (65535)
- when they are reset by a Modbus command (function 8)
- when Sepam auxiliary power is lost
- when communication parameters are modified.

**Using the counters**

Modbus diagnosis counters help to detect and resolve communication problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).

**CPT2 and CPT9 counters can be displayed on SFT2841**
("Sepam Diagnosis" screen).
An incorrect speed (or parity) increments CPT2.
Non-reception is signaled by the lack of change on CPT9.

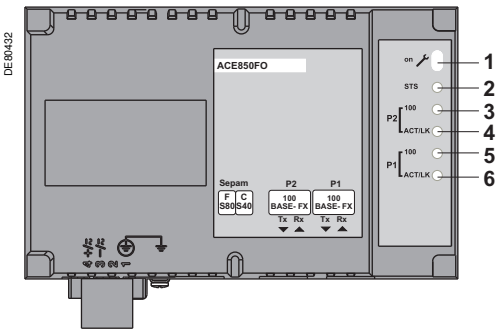
## Operating anomalies

It is advisable to connect the Sepam units to the Modbus network one by one. Make sure that the supervisor is sending frames to the relevant Sepam by checking the activity on the RS 232 - RS 485 converter or the fiber-optic converter if there is one, and on the ACE module.

**RS 485 network**
- check the wiring on each ACE module
- check the tightness of the screw terminals on each ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check that polarization is only at one point and that impedance matching is at both ends of the RS 485 network
- check the auxiliary power supply connection to the ACE969TP-2
- check that the ACE909-2 or ACE919 converter used is connected, powered and set up correctly.

**Fiber-optic network**
- check the connections on the ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check the auxiliary power supply connection to the ACE969FO-2
- check that the converter or fiber-optic star used is connected, powered and set up correctly
- for a fiber-optic ring, check that the Modbus master can handle the echo of its requests correctly.

**In all cases**
- check all the ACE configuration parameters on SFT2841
- check the CPT2 and CPT9 diagnostic counters on the SFT2841 ("Sepam Diagnosis" screen).




*ACE850 communication interface.*

## Installing the Ethernet network

**Preliminary study**

According to the installation characteristics and constraints, a technical study must first determine the Ethernet network requirements, including:

- the network topology
- the various subnets (if any) and their interconnections
- the IP addressing scheme

**Sepam operating instructions**

Communication interfaces must be installed and connected in accordance with the instructions given in this manual page 244. See also the ACE850 installation guide delivered with each ACE850, reference BBV35290.

## Preliminary checks

Perform the following actions:

- check the CCA614 cord connection between the ACE850 interface and the Sepam base unit
- check the connection of the ACE850 to the Ethernet network
- check the auxiliary power supply connection
- check the complete configuration of the ACE850.

## Checking the operation of the ACE interface

You can use the following to check that an ACE850 interface is operating correctly:

- the indicator LEDs on the front panel of the ACE850
- the information provided by the SFT2841 software connected to Sepam
- the Web pages embedded inside the ACE850.

## Basic diagnostics

**Diagnosis using indicator LEDs on the ACE850**

**1** On/fault indicator. This indicator has the following states:

- Off: the module is not powered
- steady red: the ACE850 is initializing or is faulty
- blinking red: the ACE850 is unable to establish communication with the Sepam base unit, or the ACE850 is not properly configured
- steady green: the ACE850 is operating correctly
- fast blinking green: indicates a transient state which occurs at startup when IEC 61850 communication is also used
- steady green and blinking red: communication with the base unit has been lost. This can indicate a normal situation due to a restart of the Sepam after parameters have been downloaded. The ACE850 automatically resumes normal operation in a few seconds.

This status can also indicate an error condition, in which case, ACE850 restarts automatically within 15 seconds and try to re-establish connection.

**2** Status indicator. This indicator has the following states:

- Off: the Ethernet communication is not started
- steady green: the Ethernet communication is correctly operating
- three blinks pattern: no logical Ethernet link
- four blinks pattern: duplicate IP address
- six blinks pattern: invalid IP configuration.

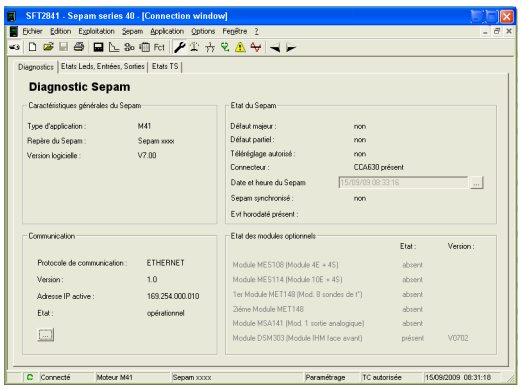
**3** and **5** Speed indicators. These indicators have the following states:

- Off: the corresponding physical link is down or the port speed is 10Mbps
- On: the corresponding port operates at 100Mbps.

**4** and **6** Link/Activity indicators. These indicators have the following states:

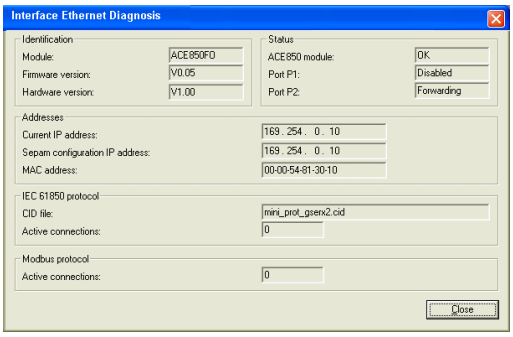
- Off: the corresponding physical link is not established
- On: the corresponding physical link is established
- blinking: the indicator blinks with the activity on the link.

PE80578




*SFT2841: Sepam diagnosis screen.*

PE80402

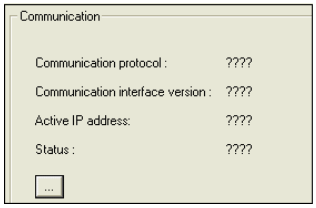



*SFT2841: Ethernet diagnosis screen.*

### Diagnosis using SFT2841 software

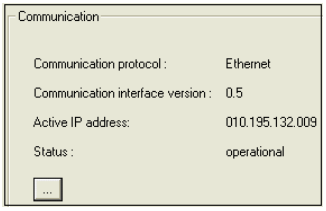
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
Sepam status information appears on the Sepam diagnosis screen on which buttons can be used to obtain detailed status information on each communication channel.
The Sepam diagnosis screen can be used to check that the Sepam base unit and the ACE850 interface are correctly connected:

PE80512




*Diagnosis screen detail:*
*ACE850 not or improperly connected.*

PE80513




*Diagnosis screen detail:*
*ACE850 connected properly.*

The Ethernet diagnosis screen can be used to check:
- the ACE850 module status. The ACE850 status is OK if the ACE850 validates its configuration.
- the communication ports status
- the current ACE850 IP address. If the current IP address is different from the one configured, this could mean that the configured address is not valid, unless the IEC 61850 protocol is also being used.

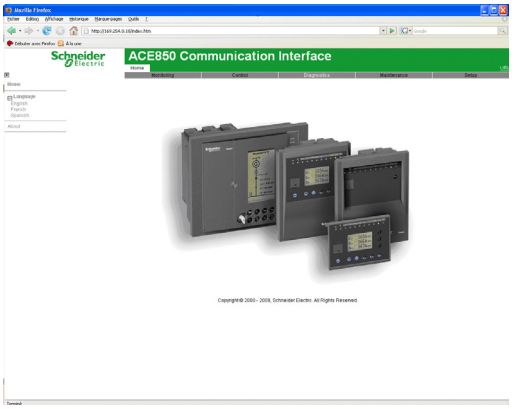
## Advanced diagnostics using the embedded Web server

The advanced diagnostics feature is only available when it is possible to establish an Ethernet connection with the ACE850. If not, the basic diagnostics must be used to solve the problems.

### Accessing the ACE850 Web server

1. Start your web browser (Internet explorer 6.0 or higher, Mozilla Firefox for example).
2. In the address text box, type the address of the ACE850 (`169.254.0.10` is the default), then press **Enter**.
3. In the login window, type your username and password (default is `Admin`, `ACE850`).
4. From the left side menu, choose the language for the current session.
5. From the menu, click **Diagnostics** to access the diagnostics menu.

PE80403




*ACE850 home page.*

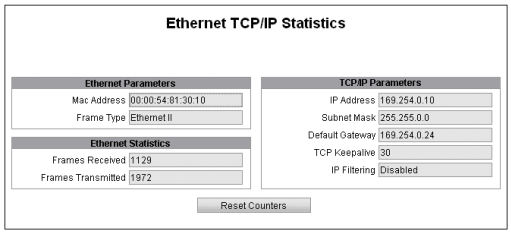
### Diagnostics Web pages

There are two general diagnostics pages dealing with Ethernet operation:
- Ethernet global statistics
- Ethernet port statistics

There is also a set of protocol dedicated diagnostic pages:
- Modbus statistics
- IEC 61850 statistics (not covered in this manual)
- SNMP statistics
- SNTP statistics
- RSTP statistics

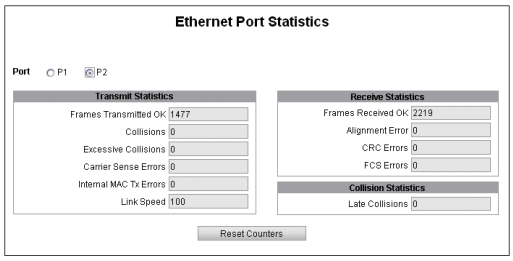
Diagnostic pages are automatically refreshed every 5 seconds (approximately).

PE80404




*ACE850 Ethernet TCP/IP statistics.*

PE80407




*ACE850 Ethernet port statistics.*

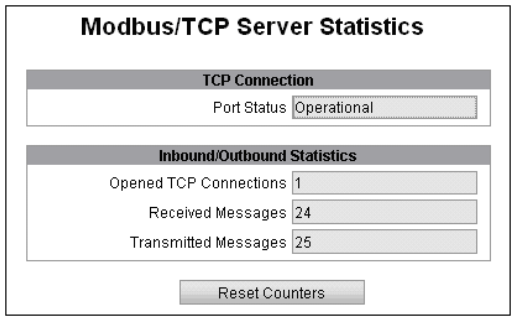
**Ethernet TCP/IP statistics**

| Item | Description |
|---|---|
| Mac address | Unique Ethernet hardware address of the ACE850 |
| Frame type | Value of the frame type configured with SFT2841 |
| TCP/IP parameters | Parameter values configured with SFT2841 |
| Frames received | Total number of received Ethernet frames, regardless of port or protocol |
| Frames transmitted | Total number of transmitted Ethernet frames, regardless of port or protocol |
| Reset Counters button | Button to reset the Ethernet counters |

**Ethernet port statistics**

| Item | Description |
|---|---|
| Port P1/P2 buttons | Selection of the port of which statistics are displayed |
| Frames transmitted OK | A counter that increments each time a frame is successfully transmitted. |
| Collisions | A counter that increments each time a frame is retransmitted due to collision detection. |
| Excessive collisions | A counter that increments each time a frame cannot be sent because it has reached the maximum collision status based on the Truncated Binary Exponential Backoff algorithm. |
| Carrier sense errors | A counter that increments each time there is a collision because carrier sense is disabled. |
| Internal MAC Tx errors | A counter that increments for every transmission error that is not caused by late, excessive, or carrier sense collisions. |
| Link speed | Actual link speed |
| Frames received OK | A counter that increments each time a frame is successfully received. |
| Alignment errors | A counter that increments each time a received frame has an FCS error and does not end on an 8-bit frame boundary. |
| CRC errors | A counter that increments each time a received frame has a CRC or an alignment error. |
| FCS errors | A counter that increments each time a received frame has a FCS or an alignment error. |
| Late collisions | A counter that increments each time a collision occurs after the slot time (512 bits starting at the preamble). |
| Reset counters button | Button to reset the port counters |

PE80408



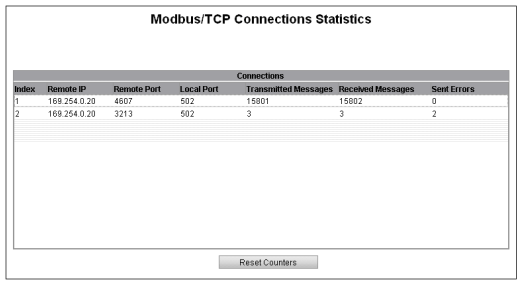

*ACE850 Modbus/TCP server statistics.*

**Modbus/TCP server statistics**

| Item | Description |
|---|---|
| Port status | Modbus port status |
| Opened TCP connections | Number of Modbus clients currently connected |
| Received messages | Total number of Modbus requests |
| Transmitted messages | Total number of Modbus responses |
| Reset counters button | Button to reset the messages counters |

***Note:*** *the Web interface uses one Modbus connection to operate.*

PPEB80409

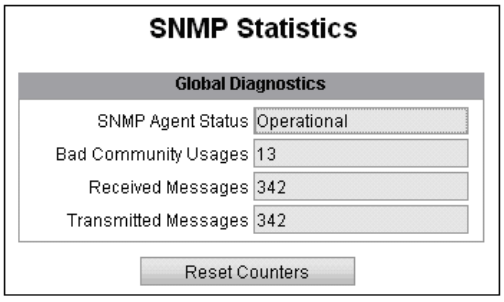

Modbus/TCP Connections Statistics
Connections
Index Remote IP Remote Port Local Port Transmitted Messages Received Messages Sent Errors
1 169.254.0.20 4607 502 15801 15802 0
2 169.254.0.20 3213 502 3 3 2
Reset Counters

*ACE850 Modbus/TCP connections statistics.*

**Modbus/TCP connections statistics**

| Item | Description |
|---|---|
| Index | Connection number |
| Remote IP | IP address of the Modbus client |
| Remote port | TCP port number on the client side |
| Local port | TCP port number on the server side |
| Transmitted messages | Number of Modbus requests for this connection |
| Received messages | Number of Modbus normal responses for this connection |
| Sent errors | Number of Modbus exception responses for this connection |
| Reset counters button | Button to reset the messages counters |

PE80410

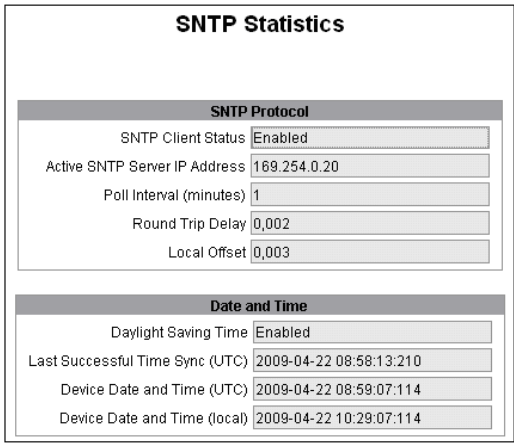



*ACE850 SNMP statistics.*

**SNMP statistics**

| Item | Description |
|---|---|
| SNMP agent status | Status of the SNMP agent |
| Bad Community usages | Number of requests with invalid community |
| Received messages | Total number of SNMP requests |
| Transmitted messages | Total number of SNMP responses |
| Reset counters button | Button to reset the messages counters |

PE80411

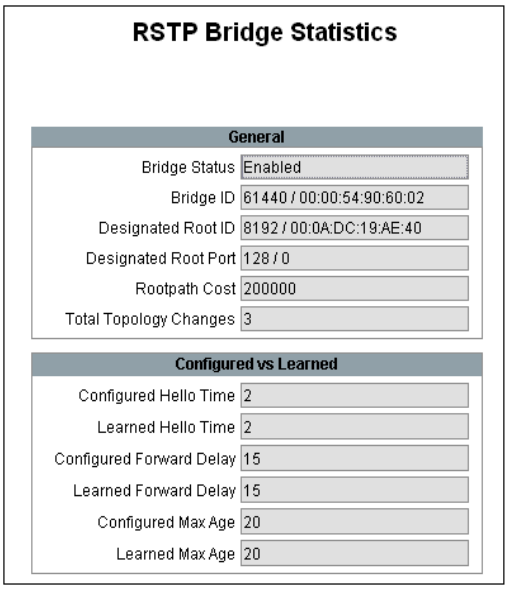



*ACE850 SNTP statistics.*

**SNTP statistics**

| Item | Description |
|---|---|
| SNTP Client status | Value configured for the parameter in SFT2841 |
| Active SNTP server IP address | Address of the server currently answering SNTP requests (0.0.0.0 if no server answer) |
| Poll interval | Value configured for the parameter in SFT2841 |
| Round trip delay | Total time for SNMP request and response messages |
| Local offset | Difference between SNTP time and ACE time |
| Daylight saving time | Value configured for the parameter in SFT2841 |
| Last Successful Time Synchronization (UTC) | Last time the ACE850 successfully contacted the SNTP server (UTC time) |
| Device Date and Time (UTC) | Current time and date of the ACE850 (UTC time) |
| Device Date and Time (local) | Current time and date of the ACE850 (local time) |

PE80412

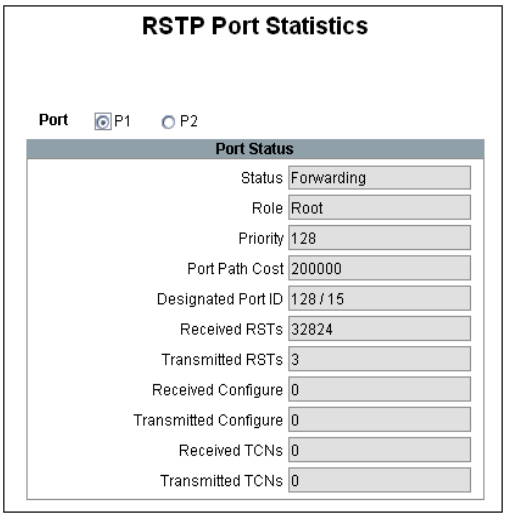



*ACE850 RSTP bridge statistics.*

**RSTP bridge statistics**

| Item | Description |
|---|---|
| Bridge status | RSTP status of the bridge |
| Bridge ID | Bridge vector (Bridge priority/Bridge Mac address) |
| Designated Root ID | Bridge vector of the RSTP root bridge |
| Designated Root Port | Identifier of the root port (priority/number) |
| Rootpath cost | Path cost to the root |
| Total topology changes | Topology change counter (as defined by 802.1D-2004) |
| Configured hello time | Value of the configured hello time |
| Learned hello time | Operational value for hello time |
| Configured forward delay | Reminder of the configured forward delay |
| Learned forward delay | Operational value for forward delay |
| Configured max age | Value of the configured max age |
| Learned max age | Operational value for max age |

PE80413




*ACE850 RSTP port statistics.*

**RSTP port statistics**

| Item | Description |
|---|---|
| Port P1 / P2 buttons | Selection of the port of which statistics are displayed |
| Status | RSTP status for the selected port |
| Role | RSTP role for the selected port |
| Priority | Port priority |
| Port path cost | Port contribution to root path cost |
| Designated port ID | Identifier of the link partner port (priority/number) |
| Received RSTs | Number of RST BPDUs received (RSTP) |
| Transmitted RSTs | Number of RST BPDUs sent (RSTP) |
| Received configure | Number of Configuration BPDUs received (STP) |
| Transmitted configure | Number of Configuration BPDUs sent (STP) |
| Received TCNs | Number of Topology change BPDUs received (STP) |
| Transmitted TCNs | Number of Topology change BPDUs sent (STP) |

# Data addresses and encoding

## CAUTION

**RISK OF DATA CORRUPTION**

When using an ACE850 communication interface with IEC 61850 communication enabled, do not use the following address zones:

- Event table 1 (0040-0060),
- Protections settings zone 1 (1E00-1F7C),
- Disturbance recording zone 1 (2200-237C).

**Failure to follow these instructions can result in equipment damage.**

## Presentation

Data which are similar from the monitoring and control application viewpoint are grouped together in adjacent address zones:

| | Hexadecimal starting address | Ending address | Modbus functions enabled |
|---|---|---|---|
| Synchronization zone | 0002 | 0005 | 3, 16 |
| Identification zone | 0006 | 000F | 3 |
| **Event table 1** | | | |
| Exchange word | 0040 | 0040 | 3, 6, 16 |
| Events (1 to 4) | 0041 | 0060 | 3 |
| **Event table 2** | | | |
| Exchange word | 0070 | 0070 | 3, 6, 16 |
| Events (1 to 4) | 0071 | 0090 | 3 |
| **Data** | | | |
| Remote control orders | 00F0 | 00F0 | 3, 4, 6, 16 |
| | 00F2 | 00F2 | 1, 2, 5, 15 (1) |
| Remote control selection | 00F1 | 00F1 | 3, 4, 6, 16 |
| | 00F3 | 00F3 | 1, 2, 5, 15 (1) |
| Status | 0100 | 0112 | 3, 4 |
| | | | 1, 2 (1) |
| Measurements | 0113 | 0158 | 3, 4 |
| Diagnosis | 0159 | 0185 | 3, 4 |
| Phase displacement | 01A0 | 01A9 | 3, 4 |
| Tripping context | 0250 | 027F | 3, 4 |
| Switchgear diagnosis | 0290 | 02A5 | 3, 4 |
| Application | 02CC | 02FE | 3 |
| Test zone | 0C00 | 0C0F | 3, 4, 6, 16 |
| | | | 1, 2, 5, 15 |
| **Protection settings zone 1** | | | |
| Read settings | 1E00 | 1E7C | 3 |
| Read request | 1E80 | 1E80 | 3, 6, 16 |
| Remote settings | 1F00 | 1F7C | 3, 6 |
| **Protection settings zone 2** | | | |
| Read settings | 2000 | 207C | 3 |
| Read request | 2080 | 2080 | 3, 6, 16 |
| Remote settings | 2100 | 217C | 3, 16 |
| **Disturbance recording zone 1** | | | |
| Record selection | 2200 | 2203 | 3, 16 |
| Identification zone | 2204 | 2271 | 3 |
| Disturb. rec. exchange word | 2300 | 2300 | 3, 6, 16 |
| Disturbance recording data | 2301 | 237C | 3 |
| **Disturbance recording zone 2** | | | |
| Record selection | 2400 | 2403 | 3, 16 |
| Identification zone | 2404 | 2471 | 3 |
| Disturb. rec. exchange word | 2500 | 2500 | 3, 6, 16 |
| Disturbance recording data | 2501 | 257C | 3 |
| **S-LAN communication monitoring** | | | |
| Time delay | 5815 | 5815 | 3, 16 (2) |

***Note:*** *non-addressable zones may reply by an exception message or else supply non-significant data.*

***(1)*** *Zones accessible in word mode or bit mode.*
*The address of bit i (0 ⩽ i ⩽ F) of address word J is then (J x 16) + i.*
*Example: 0C00 bit 0 = C000  0C00 bit 7 = C007.*
***(2)*** *Range allowed: 10 to 65535 x 100 ms (Time delay can be set from 1 to 6553.5 s with increments of 0.1 s).*

## Data encoding

**For all formats**
If a measurement overruns the maximum permissible value for the related format, the value read for the measurement will be the maximum permissible value for the format.

**16NS format**
The information is encoded in a 16-bit word, in binary format, absolute value (unsigned). The 0 bit (b0) is the least significant bit in the word.

**16S format signed measurements (temperatures,…)**
The information is encoded in a 16-bit word as a complement of 2.
Example:
- 0001 represents +1
- FFFF represents -1.

**32NS or 2 x 16NS format**
The information is encoded in two 16-bit words, in binary format, unsigned. The first word is the most significant word.

**32S format**
The information is encoded as a complement of 2 in 2 words. The first word is the most significant word:
- 0000, 0001 represents +1
- FFFF, FFFF represents -1.

**B format**
Rank i bit in the word, with i between 0 and F.

| Examples | | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS1 to TS16 | Word address 0101 | | | | | | | | | | | | | | | | |
| | | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Bit address 101x | | | | | | | | | | | | | | | | |
| TS49 to TS64 | Word address 0104 | | | | | | | | | | | | | | | | |
| | | 64 | 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 |
| | Bit address 104x | | | | | | | | | | | | | | | | |
| TC1 to TC16 | Word address 00F0 | | | | | | | | | | | | | | | | |
| | | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Bit address 0F0x | | | | | | | | | | | | | | | | |
| STC1 to STC16 | Word address 00F1 | | | | | | | | | | | | | | | | |
| | | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Bit address 0F1x | | | | | | | | | | | | | | | | |

**X format: Sepam check-word**
This format applies only to the Sepam check-word that may be accessed at the word address 0100h. This word contains various items of information relating to:
- Sepam operating mode
- time-tagging of events.

Each data item contained in the Sepam check-word may be accessed bit by bit, from address **1000** for bit 0 to **100F** for bit 15.
- bit 15 : event present in event zone 1
- bit 14 : Sepam in “data loss” status in event zone 1
- bit 13 : Sepam not synchronous
- bit 12 : Sepam time not correct
- bit 11 : presence of events in event zone 2
- bit 10 : Sepam in "data loss" status in event zone 2
- bit 9 : major fault in Sepam
- bit 8 : partial fault in Sepam
- bit 7 : setting group A in service
- bit 6 : setting group B in service
- bit 1 : Sepam in local setting mode
- other bits reserved (undetermined values).

Status changes of bits 1, 6, 7, 8, 10, 12, 13 and 14 of this word trigger the sending of a time-tagged event.

## Synchronization zone

**The synchronization zone** is a table which contains the absolute date and time for the time-tagging function. Time messages should be written in a single block containing 4 words, using function 16: write word.
Messages can be read word by word or by groups of words using function 3.

| Synchronization zone | Word address | Access | Modbus function enabled |
|---|---|---|---|
| Binary time (year) | 0002 | Read/write | 3, 16 |
| Binary time (months + days) | 0003 | Read | 3 |
| Binary time (hours + minutes) | 0004 | Read | 3 |
| Binary time (milliseconds) | 0005 | Read | 3 |

*See "time-tagging of events" chapter for data format.*

## Identification zone

**The identification zone** contains system-type information pertaining to the identification of the Sepam equipment.
Some of the information in the identification zone is also found in the configuration zone at the address 02CCh.

| Identification zone | Word address | Access | Modbus function enabled | Format | Value |
|---|---|---|---|---|---|
| Manufacturer identification | 0006 | R | 3 | | 0100 |
| Equipment identification | 0007 | R | 3 | | 0 |
| Marking + equipment type | 0008 | R | 3 | | Idem 02E2 |
| Modbus version | 0009 | R | 3 | Not managed | 0 |
| Application version | 000A/B | R | 3 | (1) | |
| Sepam check-word | 000C | R | 3 | | Idem 0100 |
| Extension word | 000D | R | 3 | Not managed | 0 |
| Command | 000E | R/W | 3/16 | Not managed | Init. to 0 |
| Extension address | 000F | R | 3 | | 02CC |

***(1)*** *MSB word 2: major index*
*LSB word 2: minor index.*

## Events 1 zone

**The event zone** is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16, and read individually using function 3.

| Events 1 zone | Word address | Access | Modbus function enabled |
|---|---|---|---|
| Exchange word | 0040 | Read/write | 3, 6, 16 |
| Event n°1 | 0041-0048 | Read | 3 |
| Event n°2 | 0049-0050 | Read | 3 |
| Event n°3 | 0051-0058 | Read | 3 |
| Event n°4 | 0059-0060 | Read | 3 |

*See "time-tagging of events" chapter for data format.*

## Events 2 zone

**The event zone** is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16 and read individually using function 3.

| Events 2 zone | Word address | Access | Modbus function enabled |
|---|---|---|---|
| Exchange word | 0070 | Read/write | 3, 6, 16 |
| Event n°1 | 0071-0078 | Read | 3 |
| Event n°2 | 0079-0080 | Read | 3 |
| Event n°3 | 0081-0088 | Read | 3 |
| Event n°4 | 0089-0090 | Read | 3 |

*See "time-tagging of events" chapter for data format.*

## Remote control zone

**The remote control zone** is a table which contains the pre-assigned remote control bits (TC). The zone may be read or written using the word functions or bit functions. The use of remote control orders is discussed in detail on page 172.

| Remote control orders | Word address | Bit address | Access | Function | Format |
|---|---|---|---|---|---|
| TC1-TC16 | 00F0 | 0F00 | R/W | 3/4/6/16<br>1/2/5/15 | B |
| STC1-STC16 | 00F1 | 0F10 | R/W | 3/4/6/16<br>1/2/5/15 | B |
| TC17-TC32 | 00F2 | 0F20 | R/W | 3/4/6/16<br>1/2/5/15 | B |
| STC17-STC32 | 00F3 | 0F30 | R/W | 3/4/6/16<br>1/2/5/15 | B |

## Status zone

The **status zone** is a table that contains the Sepam check-word, pre-assigned remote indication bits (TS), logic inputs, logic equation bits, logic outputs, LEDs and analog output control word.
The TS assignments are discussed in detail on page 169.

| Status | Word address | Bit address | Access | Modbus function enabled | Format |
|---|---|---|---|---|---|
| Sepam check-word | 0100 | 1000 | R | 3/4 or 1, 2, 7 | X |
| TS1-TS16 | 0101 | 1010 | R | 3/4 or 1, 2 | B |
| TS17-TS32 | 0102 | 1020 | R | 3/4 or 1, 2 | B |
| TS33-TS48 | 0103 | 1030 | R | 3/4 or 1, 2 | B |
| TS49-TS64 (reserved) | 0104 | 1040 | R | 3/4 or 1, 2 | B |
| TS65-TS80 | 0105 | 1050 | R | 3/4 or 1, 2 | B |
| TS81-TS96 | 0106 | 1060 | R | 3/4 or 1, 2 | B |
| TS97-TS112 | 0107 | 1070 | R | 3/4 or 1, 2 | B |
| TS113-TS128 | 0108 | 1080 | R | 3/4 or 1, 2 | B |
| TS129-TS144 | 0109 | 1090 | R | 3/4 or 1, 2 | B |
| Reserved | 010A | 10A0 | - | _ | _ |
| Logic inputs | 010B | 10B0 | R | 3/4 or 1, 2 | B |
| Logic equation bits | 010C | 10C0 | R | 3/4 or 1, 2 | B |
| Logic outputs | 010D | 10D0 | R | 3/4 or 1, 2 | B |
| LEDs | 010E | 10E0 | R | 3/4 or 1, 2 | B |
| Analog output | 010F | 10F0 | R/W | 3, 6, 16 | 16S |

**Address word 010B: logic input status (bit address 10B0 to 10BF)**

| Bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inputs | - | - | - | - | - | - | I26 | I25 | I24 | I23 | I22 | I21 | I14 | I13 | I12 | I11 |

**Address word 010C: logic equation bit status (bit address 10C0 to 10CF)**

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Equation | V8 | V7 | V6 | V5 | V4 | V3 | V2 | V1 |

| Bit | F | E | D | C | B | A | 9 | 8 |
|---|---|---|---|---|---|---|---|---|
| Equation | - | - | V_FLAGREC | V_INHIBCLOSE | V_CLOSECB | V_TRIPCB | V10 | V9 |

**Address word 010D: logic output status (bit address 10D0 to 10DF)**

| Bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Output | - | - | - | - | - | - | - | - | O14 | O13 | O12 | O11 | O4 | O3 | O2 | O1 |

**Address word 010E: LED status (bit address 10E0 à 10EF)**

| Bit | F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LED | - | - | - | - | - | - | L9 | L8 | L7 | L6 | L5 | L4 | L3 | L2 | L1 | LD |

*LD: red LED indicating Sepam unavailable.*

## Measurement zone x 1

| Measurements x 1 | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Phase current I1 (x 1) | 0113 | R | 3, 4 | 16NS | 0.1 A |
| Phase current I2 (x 1) | 0114 | R | 3, 4 | 16NS | 0.1 A |
| Phase current I3 (x 1) | 0115 | R | 3, 4 | 16NS | 0.1 A |
| Residual current I0 Sum (x 1) | 0116 | R | 3, 4 | 16NS | 0.1 A |
| Residual current measured (x 1) | 0117 | R | 3, 4 | 16NS | 0.1 A |
| Average phase current Im1 (x 1) | 0118 | R | 3, 4 | 16NS | 0.1 A |
| Average phase current Im2 (x 1) | 0119 | R | 3, 4 | 16NS | 0.1 A |
| Average phase current Im3 (x 1) | 011A | R | 3, 4 | 16NS | 0.1 A |
| Peak demand phase current IM1 (x 1) | 011B | R | 3, 4 | 16NS | 0.1 A |
| Peak demand phase current IM2 (x 1) | 011C | R | 3, 4 | 16NS | 0.1 A |
| Peak demand phase current IM3 (x 1) | 011D | R | 3, 4 | 16NS | 0.1 A |
| Phase-to-phase voltage U21 (x 1) | 011E | R | 3, 4 | 16NS | 1 V |
| Phase-to-phase voltage U32 (x 1) | 011F | R | 3, 4 | 16NS | 1 V |
| Phase-to-phase voltage U13 (x 1) | 0120 | R | 3, 4 | 16NS | 1 V |
| Phase-to-neutral voltage V1 (x 1) | 0121 | R | 3, 4 | 16NS | 1 V |
| Phase-to-neutral voltage V2 (x 1) | 0122 | R | 3, 4 | 16NS | 1 V |
| Phase-to-neutral voltage V3 (x 1) | 0123 | R | 3, 4 | 16NS | 1 V |
| Residual voltage V0 (x 1) | 0124 | R | 3, 4 | 16NS | 1 V |
| Positive sequence voltage Vd (x 1) | 0125 | R | 3, 4 | 16NS | 1 V |
| Negative sequence voltage Vi (x 1) | 0126 | R | 3, 4 | 16NS | 1 V |
| Frequency | 0127 | R | 3, 4 | 16NS | 0.01 Hz |
| Active power P (x 1) | 0128 | R | 3, 4 | 16S | 1 kW |
| Reactive power Q (x 1) | 0129 | R | 3, 4 | 16S | 1 kvar |
| Apparent power S (x 1) | 012A | R | 3, 4 | 16S | 1 kVA |
| Peak demand active power Pm (x 1) | 012B | R | 3, 4 | 16S | 1 kW |
| Peak demand reactive power Qm (x 1) | 012C | R | 3, 4 | 16S | 1 kvar |
| Power factor cos φ (x 100) | 012D | R | 3, 4 | 16S | 0.01 |
| Positive active energy Ea+ (x 1) | 012E/012F | R | 3, 4 | 2 x 16NS | 100 kW.h |
| Negative active energy Ea- (x 1) | 0130/0131 | R | 3, 4 | 2 x 16NS | 100 kW.h |
| Positive reactive energy Er+ (x 1) | 0132/0133 | R | 3, 4 | 2 x 16NS | 100 kvar.h |
| Negative reactive energy Er- (x 1) | 0134/0135 | R | 3, 4 | 2 x 16NS | 100 kvar.h |

## Measurement zone x 10

| Measurements x 10 | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Phase current I1 (x 10) | 0136 | R | 3, 4 | 16NS | 1 A |
| Phase current I2 (x 10) | 0137 | R | 3, 4 | 16NS | 1 A |
| Phase current I3 (x 10) | 0138 | R | 3, 4 | 16NS | 1 A |
| Residual current I0 Sum (x 10) | 0139 | R | 3, 4 | 16NS | 1 A |
| Residual current measured (x 10) | 013A | R | 3, 4 | 16NS | 1 A |
| Average phase current Im1 (x 10) | 013B | R | 3, 4 | 16NS | 1 A |
| Average phase current Im2 (x 10) | 013C | R | 3, 4 | 16NS | 1 A |
| Average phase current Im3 (x 10) | 013D | R | 3, 4 | 16NS | 1 A |
| Peak demand phase current IM1 (x 10) | 013E | R | 3, 4 | 16NS | 1 A |
| Peak demand phase current IM2 (x 10) | 013F | R | 3, 4 | 16NS | 1 A |
| Peak demand phase current IM3 (x 10) | 0140 | R | 3, 4 | 16NS | 1 A |
| Phase-to-phase voltage U21 (x 10) | 0141 | R | 3, 4 | 16NS | 10 V |
| Phase-to-phase voltage U32 (x 10) | 0142 | R | 3, 4 | 16NS | 10 V |
| Phase-to-phase voltage U13 (x 10) | 0143 | R | 3, 4 | 16NS | 10 V |
| Phase-to-neutral voltage V1 (x 10) | 0144 | R | 3, 4 | 16NS | 10 V |
| Phase-to-neutral voltage V2 (x 10) | 0145 | R | 3, 4 | 16NS | 10 V |
| Phase-to-neutral voltage V3 (x 10) | 0146 | R | 3, 4 | 16NS | 10 V |
| Residual voltage V0 (x 10) | 0147 | R | 3, 4 | 16NS | 10 V |
| Positive sequence voltage Vd (x 10) | 0148 | R | 3, 4 | 16NS | 10 V |
| Negative sequence voltage Vi (x 10) | 0149 | R | 3, 4 | 16NS | 10 V |
| Frequency | 014A | R | 3, 4 | 16NS | 0.01 Hz |
| Active power P (x 100) | 014B | R | 3, 4 | 16S | 100 kW |
| Reactive power Q (x 100) | 014C | R | 3, 4 | 16S | 100 kvar |
| Apparent power S (x 100) | 014D | R | 3, 4 | 16S | 100 kVA |
| Peak demand active power Pm (x 100) | 014E | R | 3, 4 | 16S | 100 kW |
| Peak demand reactive power Qm (x 100) | 014F | R | 3, 4 | 16S | 100 kvar |
| Power factor cos φ (x 100) | 0150 | R | 3, 4 | 16S | 0.01 |
| Positive active energy Ea+ (x 1) | 0151/0152 | R | 3, 4 | 2 x 16NS | 100 kW.h |
| Energie active négative Ea- (x 1) | 0153/0154 | R | 3, 4 | 2 x 16NS | 100 kW.h |
| Positive reactive energy Er+ (x 1) | 0155/0156 | R | 3, 4 | 2 x 16NS | 100 kvar.h |
| Negative reactive energy Er- (x 1) | 0157/0158 | R | 3, 4 | 2 x 16NS | 100 kvar.h |

## Diagnosis

| Diagnosis | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Peak demand Ii/Id | 0159 | L | 3, 4 | 16NS | % |
| Last tripping current Itrip1 | 015A | R | 3, 4 | 16NS | 10 A |
| Last tripping current Itrip2 | 015B | R | 3, 4 | 16NS | 10 A |
| Last tripping current Itrip3 | 015C | R | 3, 4 | 16NS | 10 A |
| Reserved | 015D | - | - | - | - |
| Cumulative breaking current | 015E | R | 3, 4 | 16NS | 1(kA)$^2$ |
| Number of operations | 015F | R | 3, 4 | 16NS | 1 |
| Operating time | 0160 | R | 3, 4 | 16NS | 1 ms |
| Charging time | 0161 | R | 3, 4 | 16NS | 0.1 s |
| Running hours counter / operation time | 0162 | R | 3, 4 | 16NS | 1 h |
| Reserved | 0163 | - | - | - | - |
| Thermal capacity used | 0164 | R | 3, 4 | 16NS | % |
| Time before tripping | 0165 | R | 3, 4 | 16NS | 1 min |
| Time before closing | 0166 | R | 3, 4 | 16NS | 1 min |
| Negative sequence / unbalance | 0167 | R | 3, 4 | 16NS | % Ib |
| Starting time / overload | 0168 | R | 3, 4 | 16NS | 0.1 s |
| Starting current / overload | 0169 | R | 3, 4 | 16NS | 1 A |
| Start inhibit time delay | 016A | R | 3, 4 | 16NS | 1 min |
| Number of starts allowed | 016B | R | 3, 4 | 16NS | 1 |
| Temperatures 1 to 16 | 016C/017B | R | 3, 4 | 16S | 1 °C (1 °F) |
| External positive active energy Ea+ ext | 017C/017D | R | 3, 4 | 32NS | 100 kW.h |
| External negative active energy Ea- ext | 017E/017F | R | 3, 4 | 32NS | 100 kW.h |
| External positive reactive energy Er+ ext | 0180/0181 | R | 3, 4 | 32NS | 100 kvar.h |
| External negative reactive energy Er- ext | 0182/0183 | R | 3, 4 | 32NS | 100 kvar.h |
| Learnt cooling time constant T2 (49 RMS) thermal rate 1 | 0184 | R | 3, 4 | 16NS | mn |
| Learnt cooling time constant T2 (49 RMS) thermal rate 2 | 0185 | R | 3, 4 | 16NS | mn |

## Phase displacement zone

| Phase displacement | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Phase displacement φ0Σ | 01A0/01A1 | L | 3, 4 | 32NS | 1° |
| Phase displacement φ0 | 01A2/01A3 | L | 3, 4 | 32NS | 1° |
| Phase displacement φ1 | 01A4/01A5 | L | 3, 4 | 32NS | 1° |
| Phase displacement φ2 | 01A6/01A7 | L | 3, 4 | 32NS | 1° |
| Phase displacement φ3 | 01A8/01A9 | L | 3, 4 | 32NS | 1° |

## Tripping context zone

| Latest tripping context | Word address Modbus | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Time-tagging of the context (see "time-tagging of events" chapter, page 173) | 0250/0253 | R | 3 | IEC | - |
| Tripping current Itrip1 | 0254 | R | 3, 4 | 32NS | 0.1 A |
| Tripping current Itrip2 | 0256 | R | 3, 4 | 32NS | 0.1 A |
| Tripping current Itrip3 | 0258 | R | 3, 4 | 32NS | 0.1 A |
| Residual current I0 Sum | 025A | R | 3, 4 | 32NS | 0.1 A |
| Residual current I0 measured | 025C | R | 3, 4 | 32NS | 0.1 A |
| Phase-to-phase voltage U21 | 025E | R | 3, 4 | 32NS | 1 V |
| Phase-to-phase voltage U32 | 0260 | R | 3, 4 | 32NS | 1 V |
| Phase-to-phase voltage U13 | 0262 | R | 3, 4 | 32NS | 1 V |
| Phase-to-neutral voltage V1 | 0264 | R | 3, 4 | 32NS | 1 V |
| Phase-to-neutral voltage V2 | 0266 | R | 3, 4 | 32NS | 1 V |
| Phase-to-neutral voltage V3 | 0268 | R | 3, 4 | 32NS | 1 V |
| Residual voltage V0 | 026A | R | 3, 4 | 32NS | 1 V |
| Positive sequence voltage Vd | 026C | R | 3, 4 | 32NS | 1 V |
| Negative sequence voltage Vi | 026E | R | 3, 4 | 32NS | 1 V |
| Frequency | 0270 | R | 3, 4 | 32NS | 0.01 Hz |
| Active power P | 0272 | R | 3, 4 | 32S | 1 kW |
| Reactive power Q | 0274 | R | 3, 4 | 32S | 1 kvar |
| Negative-sequence current Ii | 0276 | R | 3, 4 | 32NS | 0.1 A |
| Positive-sequence current Id | 0278 | R | 3, 4 | 32NS | 0.1 A |
| Faulty phase (s) | 027A | R | 3, 4 | 32NS | (1) |
| Fault location | 027C | R | 3, 4 | 32NS | m |
| Fault resistance | 027E | R | 3, 4 | 32NS | mΩ |

***(1)*** *bit 0 =* faulty phase *1*
*bit 1 =* faulty phase *2*
*bit 2 =* faulty phase *3*

## Switchgear diagnosis zone

| Switchgear diagnosis | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Initial value of cumulative breaking current | 0290 | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current (0 < I < 2 In) | 0292 | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current (2 In < I < 5 In) | 0294 | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current (5 In < I < 10 In) | 0296 | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current (10 In < I < 40 In) | 0298 | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current (I > 40 In) | 029A | R | 3, 4 | 32NS | 1 $kA^2$ |
| Cumulative breaking current | 029C | R | 3, 4 | 32NS | 1 $kA^2$ |
| Reserved | 029E | - | - | - | - |
| Number of operations (If MES114) | 02A0 | R | 3, 4 | 32NS | 1 |
| Operating time (With MES114) | 02A2 | R | 3, 4 | 32NS | 1 ms |
| Charging time (With MES114) | 02A4 | R | 3, 4 | 32NS | 1 ms |

## Configuration and application zone

| Configuration and application | Word address | Access | Modbus function enabled | Format | Unit |
|---|---|---|---|---|---|
| Type of application (1) | 02CC | R | 3 | - | - |
| Name of application (S40, S41, T42…) | 02CD/02D2 | R | 3 | ASCII 12c | - |
| Sepam marking | 02D3/02DC | R | 3 | ASCII 20c | - |
| Sepam application version | 02DD/02DF | R | 3 | ASCII 6c | - |
| Modbus address (slave number) for Level 2 | 02E0 | R | 3 | - | - |
| Modbus address (slave number) for RHM | 02E1 | R | 3 | - | - |
| Marking + type of equipment (3) | 02E2 | R | 3 | - | - |
| Type of coupler (0 = Modbus) | 02E3 | R | 3 | - | - |
| Communication version | 02E4 | R | 3 | NG | - |
| MET148-2 n° 1 module version | 02E5/02E7 | R | 3 | ASCII 6c | - |
| MET148-2 n° 2 module version | 02E8/02EA | R | 3 | ASCII 6c | - |
| MSA141 module version | 02EB/02ED | R | 3 | ASCII 6c | - |
| DSM303 module version | 02EE/02F0 | R | 3 | ASCII 6c | - |
| Name of language | 02F1/02FA | R | 3 | ASCII 20c | - |
| Customized languaged version number (2) | 02FB | R | 3 | - | - |
| English language version number (2) | 02FC | R | 3 | - | - |
| Boot version number (2) | 02FD | R | 3 | - | - |
| Extension word (4) | 02FE | R | 3 | - | - |

***(1)*** *40 : not configured 41 : S40 42 : S41 43 : S42 44 : T40*
*45 : T42 46 : M41 47 : G40 60 : S43 61 : S50*
*62 : S51 63 : S52 64 : T50 65 : T52 66 : S44*
*67 : M40 68 : S54 80 : S53*

***(2)*** *MSB: major index, LSB: minor index.*

***(3)*** *2E2 word: MSB: 11 h (Sepam series 40)*
*LSB: hardware configuration.*

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| **Option** | **MD/MX** | **Extension** | **MET148-2/2** | **DSM303** | **MSA141** | **MET148-2/1** | **MES114** | **MES108** |
| Mod.MX | 0 | z | x | x | x | x | y | y |
| Mod.MD | 1 | z | x | 0 | x | x | y | y |

x = 1 if option included
y = 1 if option included, exclusive options
z = 1 if extension in 2FE word (4).

***(4)*** *Bit 0: = 1 if MES114E or MES114F Vac set up.*

**Accuracy**
Measurement accuracy depends on the weight of the unit; it is equal to the value of the point divided by 2.

| Examples: | | |
|---|---|---|
| I1 | Unit = 1 A | Accuracy = 1/2 = 0.5 A |
| U21 | Unit = 10 V | Accuracy = 10/2 = 5 V |

## Test zone

**The test zone** is a 16-word zone that may be accessed via the communication link by all functions, in both read and write modes, to facilitate communication testing at the time of commissioning or to test the link.

| Test zone | Word address | Bit address | Access | Modbus function enabled | Format | |
|---|---|---|---|---|---|---|
| Test | 0C00 | C000-C00F | Read/write | 1, 2, 3, 4, 5, 6, 15, 16 | None | Initialized to 0 |
| | 0C0F | C0F0-C0FF | Read/write | 1, 2, 3, 4, 5, 6, 15, 16 | None | Initialized to 0 |

## Protection setting zone

**The protection setting zone** is an exchange table which is used to read and set the protection functions. 2 setting zones are available to be used by 2 masters.

| Protection setting | Word address zone 1 | Word address zone 2 | Access | Modbus function enabled |
|---|---|---|---|---|
| Setting read buffer | 1E00/1E7C | 2000/207C | R | 3 |
| Setting read request | 1E80 | 2080 | R/W | 3/6/16 |
| Remote setting request buffer | 1F00/1F7C | 2100/217C | R/W | 3/16 |

*See "Protection settings" chapter.*

## Fault recorder zone

**The fault recorder zone** is an exchange table which is used to read disturbance recording records. 2 zones are available to be used by 2 masters.

| Disturbance recording | Word address zone 1 | Word address zone 2 | Access | Modbus function enabled |
|---|---|---|---|---|
| Choice of transfer function | 2200/2203 | 2400/2403 | R/W | 3/16 |
| Identification zone | 2204/2228 | 2404/2428 | R | 3 |
| Disturb. rec. exchange zone | 2300 | 2500 | R/W | 3/6/16 |
| Disturbance recording data | 2301/237C | 2501/257C | R | 3 |

*See "Disturbance recording" chapter.*

## Use of remote indication bits

Sepam provides the communication link with 144 TS.
The remote indications (TS) are pre-assigned to protection and control functions which depend on the Sepam model.
The TSs may be read using the bit or word functions. Each TS transition is time-tagged and stored in the event stack (see “Time-tagging”, page 173).

**Address word 0101: TS1 to TS16 (Bit address 1010 to 101F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Protection 50/51 unit 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 2 | Protection 50/51 unit 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 3 | Protection 50/51 unit 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 4 | Protection 50/51 unit 4 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 5 | Protection 50N/51N unit 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 6 | Protection 50N/51N unit 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7 | Protection 50N/51N unit 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 8 | Protection 50N/51N unit 4 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 9 | Protection 49 RMS alarm set point | | | | | | ■ | ■ | ■ | ■ | ■ |
| 10 | Protection 49 RMS tripping set point | | | | | | ■ | ■ | ■ | ■ | ■ |
| 11 | Protection 37 | | | | | | | | ■ | ■ | |
| 12 | Protection 46 unit 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 13 | Protection 46 unit 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 14 | Protection 48/51LR/14 (locked rotor) | | | | | | | | ■ | ■ | |
| 15 | Protection 48/51LR/14 (rotor locking on start) | | | | | | | | ■ | ■ | |
| 16 | Protection 48/51LR/14 (excessive starting time) | | | | | | | | ■ | ■ | |

**Address word 0102: TS17 to TS32 (Bit address 1020 to 102F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Protection 27D unit 1 | | | | | | | | ■ | ■ | |
| 18 | Protection 27D unit 2 | | | | | | | | ■ | ■ | |
| 19 | Protection 27/27S unit 1 | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 20 | Protection 27/27S unit 2 | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ |
| 21 | Protection 27R | | | | | | | | ■ | ■ | |
| 22 | Protection 59 unit 1 | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 23 | Protection 59 unit 2 | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 24 | Protection 59N unit 1 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 25 | Protection 59N unit 2 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 26 | Protection 81H unit 1 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 27 | Protection 81H unit 2 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 28 | Protection 81L unit 1 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 29 | Protection 81L unit 2 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 30 | Protection 81L unit 3 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 31 | Protection 81L unit 4 | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ |
| 32 | Protection 66 | | | | | | | | ■ | ■ | |

**Address word 0103: TS33 to TS48 (Bit address 1030 to 103F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | Protection 67 unit 1 | | | ■ | | | | ■ | | | |
| 34 | Protection 67 unit 2 | | | ■ | | | | ■ | | | |
| 35 | Protection 67N unit 1 | | ■ | ■ | ■ | | | ■ | | ■ | |
| 36 | Protection 67N unit 2 | | ■ | ■ | ■ | | | ■ | | ■ | |
| 37 | Protection 47 | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ |
| 38 | Protection 32P | | ■ | ■ | ■ | | | | | ■ | ■ |
| 39 | Protection 50BF | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 40 | Protection 32Q | | | | | | | | | ■ | ■ |
| 41 | Protection 51V | | | | | | | | | | ■ |
| 42 | TC fault | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 43 | TP Phase fault | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 44 | TP V0 fault | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 45 | *Reserved* | | | | | | | | | | |
| 46 | *Reserved* | | | | | | | | | | |
| 47 | *Reserved* | | | | | | | | | | |
| 48 | *Reserved* | | | | | | | | | | |

**Address word 0104: TS49 to TS64 (Bit address 1040 to 104F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | *Reserved* | | | | | | | | | | |
| 50 | *Reserved* | | | | | | | | | | |
| 51 | *Reserved* | | | | | | | | | | |
| 52 | *Reserved* | | | | | | | | | | |
| 53 | *Reserved* | | | | | | | | | | |
| 54 | *Reserved* | | | | | | | | | | |
| 55 | *Reserved* | | | | | | | | | | |
| 56 | *Reserved* | | | | | | | | | | |
| 57 | *Reserved* | | | | | | | | | | |
| 58 | *Reserved* | | | | | | | | | | |
| 59 | *Reserved* | | | | | | | | | | |
| 60 | *Reserved* | | | | | | | | | | |
| 61 | *Reserved* | | | | | | | | | | |
| 62 | *Reserved* | | | | | | | | | | |
| 63 | *Reserved* | | | | | | | | | | |
| 64 | *Reserved* | | | | | | | | | | |

**Address word 0105: TS65 to TS80 (Bit address 1050 to 105F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | Protection 38/49T module 1 alarm set point sensor 1 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 66 | Protection 38/49T module 1 tripping set point sensor 1 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 67 | Protection 38/49T module 1 alarm set point sensor 2 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 68 | Protection 38/49T module 1 tripping set point sensor 2 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 69 | Protection 38/49T module 1 alarm set point sensor 3 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 70 | Protection 38/49T module 1 tripping set point sensor 3 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 71 | Protection 38/49T module 1 alarm set point sensor 4 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 72 | Protection 38/49T module 1 tripping set point sensor 4 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 73 | Protection 38/49T module 1 alarm set point sensor 5 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 74 | Protection 38/49T module 1 tripping set point sensor 5 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 75 | Protection 38/49T module 1 alarm set point sensor 6 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 76 | Protection 38/49T module 1 tripping set point sensor 6 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 77 | Protection 38/49T module 1 alarm set point sensor 7 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 78 | Protection 38/49T module 1 tripping set point sensor 7 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 79 | Protection 38/49T module 1 alarm set point sensor 8 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 80 | Protection 38/49T module 1 tripping set point sensor 8 | | | | | | ■ | ■ | ■ | ■ | ■ |

**Address word 0106: TS81 to TS96 (Bit address 1060 to 106F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 | Protection 38/49T module 2 alarm set point sensor 1 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 82 | Protection 38/49T module 2 tripping set point sensor 1 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 83 | Protection 38/49T module 2 alarm set point sensor 2 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 84 | Protection 38/49T module 2 tripping set point sensor 2 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 85 | Protection 38/49T module 2 alarm set point sensor 3 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 86 | Protection 38/49T module 2 tripping set point sensor 3 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 87 | Protection 38/49T module 2 alarm set point sensor 4 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 88 | Protection 38/49T module 2 tripping set point sensor 4 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 89 | Protection 38/49T module 2 alarm set point sensor 5 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 90 | Protection 38/49T module 2 tripping set point sensor 5 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 91 | Protection 38/49T module 2 alarm set point sensor 6 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 92 | Protection 38/49T module 2 tripping set point sensor 6 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 93 | Protection 38/49T module 2 alarm set point sensor 7 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 94 | Protection 38/49T module 2 tripping set point sensor 7 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 95 | Protection 38/49T module 2 alarm set point sensor 8 | | | | | | ■ | ■ | ■ | ■ | ■ |
| 96 | Protection 38/49T module 2 tripping set point sensor 8 | | | | | | ■ | ■ | ■ | ■ | ■ |

**Address word 0107: TS97 to TS112 (Bit address 1070 to 107F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 97 | Recloser in service | ■ | ■ | ■ | ■ | ■ | | | | | |
| 98 | Recloser in progress | ■ | ■ | ■ | ■ | ■ | | | | | |
| 99 | Recloser final trip | ■ | ■ | ■ | ■ | ■ | | | | | |
| 100 | Recloser successful reclosing | ■ | ■ | ■ | ■ | ■ | | | | | |
| 101 | Send blocking input 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 102 | Remote setting inhibited | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 103 | Remote control inhibited | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 104 | Sepam not reset after fault | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 105 | TC/ position discrepancy | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 106 | Matching fault or Trip Circuit Supervision | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 107 | Disturbance recording stored | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 108 | Control fault | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 109 | Disturbance recording inhibited | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 110 | Thermal protection inhibited | | | | | | ■ | ■ | ■ | ■ | ■ |
| 111 | MET148-1 module sensor fault | | | | | | ■ | ■ | ■ | ■ | ■ |
| 112 | MET148-2 module sensor fault | | | | | | ■ | ■ | ■ | ■ | ■ |

**Address word 0108: TS113 to TS128 (Bit address 1080 to 108F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 113 | Thermistor tripping | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 114 | Thermistor alarm | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 115 | External tripping 1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 116 | External tripping 2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 117 | External tripping 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 118 | Buchholz tripping | | | | | | ■ | ■ | | | |
| 119 | Thermostat tripping | | | | | | ■ | ■ | | | |
| 120 | Pressure tripping | | | | | | ■ | ■ | | | |
| 121 | Buchholz alarm | | | | | | ■ | ■ | | | |
| 122 | Thermostat alarm | | | | | | ■ | ■ | | | |
| 123 | Pressure alarm | | | | | | ■ | ■ | | | |
| 124 | SF6 alarm | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 125 | Recloser ready | ■ | ■ | ■ | ■ | ■ | | | | | |
| 126 | Inductive (1) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 127 | Capacitive (1) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 128 | Phase inverse rotation | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

***(1)*** *TC17 can be used to inhibit this TS.*

**Address word 0109: TS129 to TS144 (Bit address 1090 to 109F)**

| TS | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 129 | Send blocking input 2 | | | ■ | | | | | | | |
| 130 | Tripping due to protection | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 131 | S-LAN communication monitoring enabled | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 132 | 46BC protection (2) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 133 | *Reserved* | | | | | | | | | | |
| 134 | *Reserved* | | | | | | | | | | |
| 135 | *Reserved* | | | | | | | | | | |
| 136 | *Reserved* | | | | | | | | | | |
| 137 | *Reserved* | | | | | | | | | | |
| 138 | *Reserved* | | | | | | | | | | |
| 139 | *Reserved* | | | | | | | | | | |
| 140 | *Reserved* | | | | | | | | | | |
| 141 | *Reserved* | | | | | | | | | | |
| 142 | *Reserved* | | | | | | | | | | |
| 143 | *Reserved* | | | | | | | | | | |
| 144 | *Reserved* | | | | | | | | | | |

***(2)*** *Only available on S5X and T5X applications.*

## Use of remote control orders

Remote control orders are pre-assigned to protection, control and metering functions.
Remote control orders may be carried out in two modes:
- direct mode
- confirmed SBO (select before operate) mode.

It is possible to inhibit all the remote control orders via one logic input assigned to the function "inhibit remote control", with the exception of the remote control tripping order TC1 which can be activated at any time.
The parameter setting of the logic input may be done in two modes:
- inhibition if the input is at 1
- inhibition if the input is at 0 (negative input)

The device tripping and closing and recloser enabling and disabling remote control orders are acknowledged if the "CB control" function is confirmed and if the inputs required for that logic are present on the MES114 (or MES108) optional module.

**Direct remote control order**

The remote control order is executed when it is written in the remote control word. The program logic resets it to zero after the remote control order is acknowledged.

**Confirmed SBO remote control order**

(select before operate)
In this mode, remote control orders involve two steps:
- selection by the master of the order to be sent by writing the bit in the STC word and checking of the selection by rereading the word
- execution of the order to be sent by writing the bit in the TC word.

The remote control order is executed if the bit in the STC word and the bit in the associated word are set: the program logic resets the STC bit and TC bits to zero after the remote control order is acknowledged.
Deselection of the STC bit takes place:
- if the master deselects it by writing in the STC word
- if the master selects (write bit) a bit other than the one already selected
- if the master sets a bit in the TC word which does not match the selection. In this case, no remote control order is executed.

**Address word 00F0: TC1 to TC16 (Bit address 0F00 to 0F0F)**

| TC | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Tripping | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 2 | Closing | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 3 | Swtiching to setting group A | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 4 | Switching to setting group B | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 5 | Sepam reset | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 6 | Peak demand current zero reset (2) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7 | Inhibit thermal protection | | | | | | ■ | ■ | ■ | ■ | ■ |
| 8 | Inhibit disturbance recording triggering (OPG (1)) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 9 | Confirm disturbance recording triggering (OPG (1)) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 10 | Manual disturbance recording triggering (OPG (1)) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 11 | Enable recloser | ■ | ■ | ■ | ■ | ■ | | | | | |
| 12 | Disable recloser | ■ | ■ | ■ | ■ | ■ | | | | | |
| 13 | Confirm thermal protection | | | | | | ■ | ■ | ■ | ■ | ■ |
| 14 | Reset undercurrent protection | | | | | | | | ■ | ■ | |
| 15 | S-LAN communication monitoring activation (3) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 16 | S-LAN communication monitoring inhibition | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

***(1)*** *OPG : French acronym for disturbance recording.*
***(2)*** *Zero resetting of all the peak demands except the peak demand of the negative and positive sequence current ratio.*
***(3)*** *TC15 Remote control order follows the same TC1 inhibition mode.*

**Address word 00F2: TC17 to TC32 (Bit address 0F20 to 0F2F)**

| TC | Application | S40 S50 | S41 S51 | S42 S52 | S43 S53 | S44 S54 | T40 T50 | T42 T52 | M40 | M41 | G40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Inhibit TS126 (Inductive) and TS127 (Capacitive) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 18 | Confirm TS126 (Inductive) and TS127 (Capacitive) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 19-32 | *Reserved* | | | | | | | | | | |

## Remote control of the analog output

The analog output of the MSA141 module may be set up for remote control via the Modbus communication link (word address 010F). The usable range of the numerical value transmitted is defined by the "min. value" and "max. value" settings of the analog output.
This function is not affected by remote control inhibition conditions.

# Time-tagging of events

## Presentation

The communication system time-tags the data processed by Sepam. The time-tagging function assigns a date and precise time to status changes so that they can be accurately classified over time.
Time-tagged data are events that can be processed in the control room by the remote monitoring and control system using the communication protocol for the data logging and chronological display functions.
Sepam time-tags the following data:
- logic inputs
- remote indications
- information pertaining to Sepam equipment (see Sepam check-word).

Time-tagging is carried out systematically.
The remote monitoring and control system provides a chronological display of the time-tagged data.

## Time-tagging

Sepam time-tagging of events uses absolute time (see section on date and time). When an event is detected, it is tagged with the absolute time given by Sepam's internal clock.
All the Sepam internal clocks must be synchronized so as to avoid drifts and all be the same, thereby allowing inter-Sepam chronological sorting.
Sepam has two mechanisms for managing its internal clock:
- **time-setting**:

to initialize or modify the absolute time. A special Modbus message, called "time message", is used to time-set each Sepam
- **synchronization**:

to avoid Sepam internal clock drifts and ensure inter-Sepam synchronization.
Synchronization may be carried out according to two principles:
- **internal synchronization**:

via the communication network without any additional wiring
- **external synchronization**:

via a logic input with additional wiring.
At the time of commissioning, the user sets the synchronization mode parameter.

**Initialization of the time-tagging function**
Each time the communication system is initialized (energizing of Sepam), the events are generated in the following order:
- appearance of "data loss"
- appearance of "incorrect time"
- appearance of "not synchronous"
- disappearance of "data loss".

The function is initialized with the current values of the remote indication and logic input status without creating any events related to those data. After the initialization phase, event detection is activated.
It can only be interrupted by saturation of the internal event storage queue or by the presence of a major fault in Sepam.

## Date and time

**Presentation**
An absolute date and time are generated internally by Sepam, comprising the following information: Year: Month: Day: Hour: minute: millisecond.
The date and time format is standardized (ref.: IEC 60870-5-4).

**Power failure protection**
The internal clock of Sepam is saved for 24 hours. After a power outage that lasts for more than 24 hours, the time must be reset.
The period over which Sepam data and time settings are maintained in the event of a power outage depends on the ambient temperature and the age of the Sepam unit.
Typical values:

| ■ at 25 °C | ■ at 40 °C |
|---|---|
| □ 24 hours for 7 years | □ 24 hours for 3 years |
| □ 18 hours for 10 years | □ 16 hours for 10 years |
| □ 14 hours for 15 years | □ 10 hours for 15 years |

**Resetting the date and time**
The internal clock of Sepam may be time-set in three different ways:
- by the remote monitoring and control system, via the Modbus link,
- via the SFT2841 software tool, "General characteristics" screen
- via the display of Sepam units equipped with the advanced UMI.

The time tagged on events is encoded in 8 bytes as follows:

| b15 | b14 | b13 | b12 | b11 | b10 | b09 | b08 | b07 | b06 | b05 | b04 | b03 | b02 | b01 | b00 | word |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Y | Y | Y | Y | Y | Y | Y | word 1 |
| 0 | 0 | 0 | 0 | M | M | M | M | 0 | 0 | 0 | D | D | D | D | D | word 2 |
| 0 | 0 | 0 | H | H | H | H | H | 0 | 0 | mn | mn | mn | mn | mn | mn | word 3 |
| ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | word 4 |

**Y** - 1 byte for years: varies from 0 to 99 years.
The remote monitoring and control system must ensure that the year 00 is greater than 99.
**M** - 1 byte for months: varies from 1 to 12.
**D** - 1 byte for days: varies from 1 to 31.
**H** - 1 byte for hours: varies from 0 to 23.
**mn** - 1 byte for minutes: varies from 0 to 59.
**ms** - 2 bytes for milliseconds: varies from 0 to 59999.
These data are encoded in binary format. Sepam is time-set via the "write word" function (function 16) at the address 0002 with a mandatory 4-word time message.
The bits set to "0" in the description above correspond to format fields which are not used in and not managed by Sepam.
Since these bits can be transmitted to Sepam with random values, Sepam performs the necessary disabling.
Sepam does not check the consistency or validity of the date and time received.

## Synchronization clock

A synchronization clock is required to set the Sepam date and time;
Schneider Electric has tested the following equipment:
Gorgy Timing, ref. RT300, equipped with the M540 module.

## Reading of events

Sepam provides the master or masters with two event tables. The master reads the event table and acknowledges by writing the exchange word. Sepam updates its event table.

**The events sent by Sepam are not sorted chronologically.**

**Structure of event table 1:**
- exchange word 0040h
- event number 1

0041h ... 0048h
- event number 2

0049h ... 0050h
- event number 3

0051h ... 0058h
- event number 4

0059h ... 0060h

**Structure of event table 2:**
- exchange word 0070h
- event number 1

0071h ... 0078h
- event number 2

0079h ... 0080h
- event number 3

0081h ... 0088h
- event number 4

0089h ... 0090h

The master has to read a block of 33 words starting at the address 0040h/0070h, or 1 word at the address 0040h/0070h.

**Exchange word**

The exchange word is used to manage a special protocol to be sure not to lose events following a communication problem. The event table is numbered for that purpose.

The exchange word includes two fields:
- most significant byte (MSB) = exchange number (8 bits): 0..255

| b15 | b14 | b13 | b12 | b11 | b10 | b09 | b08 |
|---|---|---|---|---|---|---|---|
| Exchange number: 0 .. 255 | | | | | | | |

*Description of the MSB of the exchange word.*

The exchange number contains a numbering byte which identifies the exchanges. The exchange number is initialized to zero when Sepam is energized. When it reaches its maximum value (FFh), it automatically returns to 0.

Sepam numbers the exchanges and the master acknowledges the numbering.

- least significant byte (LSB) = number of events (8 bits): 0..4.

| b07 | b06 | b05 | b04 | b03 | b02 | b01 | b00 |
|---|---|---|---|---|---|---|---|
| Number of events: 0 .. 4 | | | | | | | |

*Description of the LSB of the exchange word.*

Sepam indicates the number of significant events in the event table in the least significant byte of the exchange word. Each non-significant event word is initialized to zero.

**Event table acknowledgment**

To inform Sepam that the block read by the master has been correctly received, the master writes the number of the last exchange made in the "Exchange number" field, and resets the "Number of events" field of the exchange word to zero. After acknowledgment, the 4 events in the event table are initialized to zero and the old, acknowledged events are erased in Sepam.

Until the exchange word written by the master becomes "X,0" (with X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at "X, number of previous events".

Sepam only increments the exchange number when new events are present (X+1, number of new events).

If the event table is empty, Sepam performs no processing operations when the master reads the event table or the exchange word.

The data are encoded in binary format.

**Clearing an event queue**

Writing a value "xxFFh" in the exchange word (any exchange number, event number = FFh) reinitializes the corresponding event queue (all stored events not yet transmitted are deleted).

This command leads the reset of the bits 10, 11, 14 and 15 of the control word without associated event generation.

**Sepam in data loss (1) / no data loss (0) status**

Sepam has two internal storage queues with a capacity of 64 events. If one of the queues becomes saturated, i.e. 63 events already present, the "**data loss**" event is generated by Sepam in the 64th position.

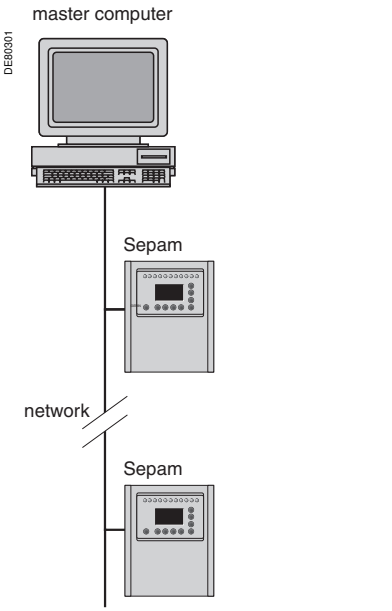
The detection of events stops and the most recent events are lost.

### Description of event encoding

An event is encoded in 8 words with the following structure:

| Most significant byte | Least significant byte | |
|---|---|---|
| **Word 1: type of event** | | |
| 08 | 00 | For remote indications, internal data logic inputs |
| **Word 2: event address** | | |
| | | See bit adresses 1000 to 10BF |
| **Word 3: reserved** | | |
| 00 | 00 | |
| **Word 4: falling edge: disappearance or rising edge: appearance** | | |
| 00 | 00 | Falling edge |
| 00 | 01 | Rising edge |
| **Word 5: year** | | |
| 00 | 0 to 99 (year) | |
| **Word 6: month-day** | | |
| 1 to 12 (month) | 1 to 31 (day) | |
| **Word 7: hours-minutes** | | |
| 0 to 23 (hours) | 0 to 59 (minutes) | |
| **Word 8: milliseconds** | | |
| 0 to 59999 | | |

# Time-tagging of events




*Architecture for "internal synchronization" via the communication network.*

## Synchronization

Sepam accommodates two synchronization modes:

- "internal via the network" synchronization mode by the broadcasting of a "time message" frame via the communication network. Slave number 0 is used for broadcasting
- "external" synchronization mode via a logic input.

The synchronization mode is selected at the time of commissioning via SFT2841.

**Internal synchronization via the network mode**

The “time message" frame is used for both time-setting and synchronization of Sepam. In this case, it must be sent regularly at brief intervals (between 10 and 60 seconds) in order for synchronous time to be obtained.

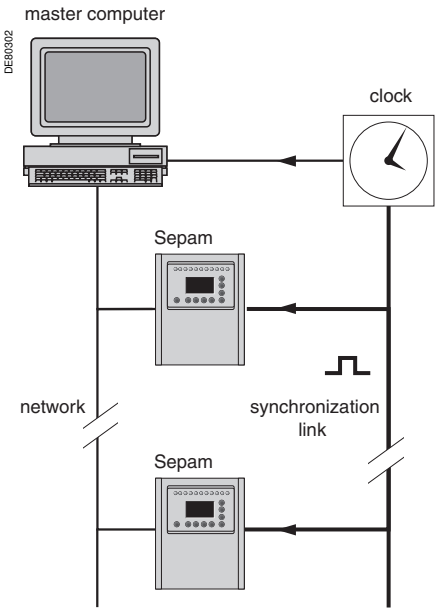
Sepam’s internal clock is reset each time a new time frame is received, and synchronization is maintained if the difference in synchronism is less than 100 milliseconds.

With internal synchronization via the network, accuracy is linked to the master and its mastery of time frame transmission in the communication network.

Sepam is synchronized without delay at the end of the receipt of the frame.

Time changes are made by sending a frame to Sepam with the new date and time. Sepam then switches into a transitional non-synchronous status.

When Sepam is in synchronous status, if no "**time message**” is received for 200 seconds, the appearance of the "not synchronous" event is triggered.




*Architecture for "external synchronization" via a logic input.*

## Synchronization (cont'd)

**External synchronization via a logic input mode**

Sepam can be synchronized externally by means of a logic input (I21) (the MES114 module is required).

The synchronization pulse is determined by the rising edge of the logic input.

Sepam can adapt to all synchronization pulse periods from 10 to 60 s, by 10 s steps.

The shorter the synchronization period, the more accurate time-tagging of status changes is.

The first time frame is used to initialize Sepam with the absolute date and time (the following frames are used for the detection of any time changes).

The synchronization pulse is used to reset Sepam's internal clock. In the initialization phase, when Sepam is in "non-synchronous" mode, resetting is allowed, within an amplitude of ±4 seconds.

In the initialization phase, the resetting process (switching of Sepam into "synchronous" mode) is based on a measurement of the difference between Sepam's current time and the nearest ten second period. This measurement is taken at the time of the receipt of the synchronization pulse following the initialization time frame. Resetting is allowed if the difference is less than or equal to 4 seconds, in which case Sepam switches to "synchronous" mode.

As of that time (after the switching to "synchronous" mode), the resetting process is based on the measurement of a difference (between Sepam's current time and the nearest ten second period at the time of the receipt of a synchronization pulse), which is adapted to match the synchronization pulse period.

**The synchronization pulse period is determined automatically by Sepam when it is energized, based on the first two pulses received: the synchronization pulse must therefore be operational before Sepam is energized.**

**The synchronization function only operates after Sepam has been time-set, i.e. after the disappearance of the "incorrect time" event.**

Any time changes greater than ±4 seconds in amplitude are made by sending a new time frame. The switch from summer time to winter time (and vice versa) is made in this way as well.

There is a temporary loss of synchronism when the time is changed.

The external synchronization mode requires additional equipment, a "synchronization clock " to generate a precise periodic synchronization time pulse.

If Sepam is in "correct time and synchronous" status, and if the difference in synchronism between the nearest ten second period and the receipt of the synchronization pulse is greater than the synchronism error for 2 consecutive synchronization pulses, it switches into non-synchronous status and generates the appearance of a "not synchronous" event.

Likewise, if Sepam is in "correct time and synchronous" status, the failure to receive a synchronization pulse for 200 seconds generates the appearance of a "not synchronous" event.

## Reading of remote settings (remote reading)

**Settings accessible for remote reading**
Reading of the settings of all the protection functions may be accessed remotely in 2 independent zones to enable operation with 2 masters.

**Exchange principle**
Remote reading of settings (remote reading) takes place in two steps:
■ first of all, the master indicates the code of the function for which it wishes to know the settings by means of a "request frame". The request is acknowledged, in the Modbus sense of the term, to free the network
■ the master then reads a reply zone to find the required information by means of a "reply frame". Each function has its own particular reply zone contents. The time needed between the request and the reply is linked to Sepam's low-priority cycle time and may vary from a few tens to several hundreds of milliseconds.
■ setting zone 1
□ read: 1E00h-1E7Ch
□ read request: 1E80h
□ remote setting: 1F00h-1F7Ch
■ setting zone 2
□ read: 2000h -207Ch
□ read request: 2080h
□ remote setting: 2100h -217Ch

**Request frame**
The request is made by the master using a "write word" operation (function 6 or 16) at the address 1E80h or 2080h of a 1-word frame consisting of the following:

**1E80h/2080h**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Function code | | | | | | | | Unit number | | | | | | | |

The content of the address 1E80h/2080h may be read using a Modbus "read word" operation (function 3).
The function code field may have the following values:
■ 01h to 99h (BCD encoding) for protection functions.
The unit number field is used as follows:
■ for protection functions, it indicates the unit involved, varying from 1 to N, N being the maximum number of relays available in the Sepam
■ when only one unit of a protection function is available, this number field is not controlled.

**Exception replies**
In addition to the usual cases, Sepam can send Modbus type 07 exception replies (not acknowledged) if another remote reading request is being processed.

**Reply frame**
The reply, sent back by Sepam, fits into a zone with a maximum length of 25 words at the address 1E00h or 2000h, which comprises the following:

**1E00h-1E7Ch/2000h-207Ch**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Function code | | | | | | | | Unit number | | | | | | | |
| Settings | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |
| (special field for each function) | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |

This zone is read by a Modbus "read word" operation (function 3) at the address 2000h.
The length of the exchange may concern:
■ first word only (validity test)
■ maximum size of the zone (125 mots)
■ usable size of the zone (determined by the function being addressed).
However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address").
The first word in the zone (function code and unit number) may have the following values:
■ **xxyy**: with
□ function code xx different from 00 and FFh
□ unit number yy different from FFh.
The settings are available and confirmed. They word is a copy of the "request frame". The zone contents remain valid until the next request is made.
■ **FFFFh**: the "request frame" has been processed, but the results in the "reply zone" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
■ **xxFFh**: with the function code xx different from 00 and FFh. The read request for the settings of the designated function is not valid. The function is not included in the particular Sepam, or remote reading of it is not authorized: refer to the list of functions which accommodate remote reading of settings.

**CAUTION**

**RISK OF UNINTENDED OPERATION**

■ The device must only be configured and set by qualified personnel, using the results of the installation protection system study.

■ During commissioning of the installation and following any modification, check that the Sepam configuration and protection function settings are consistent with the results of this study.

**Failure to follow these instructions can result in equipment damage.**

## Remote setting

**Data that can be remotely set**

Writing of the settings of all the protection functions may be accessed remotely.

**Exchange principle**

Remote setting is allowed for Sepam units.

Remote setting is carried out for a given function unit by unit.

It takes place in two steps:

■ first of all, the master indicates the function code and unit number, followed by the values of all the settings in the "write request frame". The request is acknowledged to free the network

■ the master then reads a reply zone designed for checking that the settings have been processed. Each function has its own particular reply zone contents.

They are the same as those of the remote reading function reply frame.

To use remote setting, it is necessary to make all the settings for the function concerned, even if some of them have not changed.

**Request frame**

The request is made by the master using a "write n words" operation (function 16) at the address 1F00h or 2100h. The zone to be written contains a maximum of 123 words.

It contains the values of all the settings and consists of the following:

**1F00h/2100h**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Function code | | | | | | | | Unit number | | | | | | | |
| Settings | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |
| (special field for each function) | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |

The content of the address 2100h may be read using a "read n words" operation (function 3).

■ the function code field may have the following values:

01h to 99h (BCD encoding) for the list of protection functions F01 to F99

■ the unit number field is used as follows:

for protection functions, it indicates the unit involved, varying from 1 to N, N being the maximum number of units available in the Sepam. It may never be equal to 0.

**Exception reply**

In addition to the usual cases, le Sepam can send type 07 exception replies (not acknowledged) if:

■ another remote reading or setting request is being processed

■ the remote setting function is inhibited.

**Reply frame**

The reply sent back by Sepam is the same as the remote reading reply frame. It fits into a zone with a maximum length of 125 words at the address 1E00h or 2000h, and is composed of the effective settings of the function following a semantic check:

**1E00h-1E7Ch/2000h-207Ch**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Function code | | | | | | | | Unit number | | | | | | | |
| Settings | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |
| (special field for each function) | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |

This zone is read by a "read n words" operation (function 3) at the address 1E00h or 2000h.

The length of the exchange may concern:

- first word only (validity test)
- maximum size of the zone (125 words)
- usable size of the zone (determined by the function being addressed).

However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address").

The first word in the zone (function code and unit number) has the same values as those described for the remote reading reply frame.

- **xxyy**: with:
  - function code xx different from 00 and FFh
  - unit number yy different from FFh.

The settings are available and confirmed. The word is a copy of the "request frame". The zone contents remain valid until the next request is made.

- **0000h**: no "request frame has yet been formulated.

This is espcially the case when Sepam is energized.

The other words are not significant.

- **FFFFh**: the "request frame" has been processed, but the results in the "reply zone" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
- **xxFFh**: with the function code xx different from 00 and FFh. The read request for the settings of the designated function is not valid. The function is not included in the particular Sepam, or access to settings is impossible, in both read and write modes.

## Description of settings

**Data format**
All the settings are transmitted in signed 32-bit integer format (encoding, as a complement of 2).
Particular setting value:
7FFF FFFFh means that the setting is out of the validity range.

① The Enabled or Disabled setting is encoded as follows:
0 = Disabled, 1 = Enabled

② The tripping curve setting is encoded as follows:
0 = definite
1 = inverse
2 = long time inverse
3 = very inverse
4 = extremely inverse
5 = ultra inverse
6 = RI
7 = IEC SIT/A
8 = IEC LTI/B
9 = IEC VIT/B
10 = IEC EIT/C
11 = IEEE Mod. inverse
12 = IEEE Very inverse
13 = IEEE Extr. inverse
14 = IAC inverse
15 = IAC very inverse
16 = IAC extr. inverse

③ The timer hold delay curve setting is encoded as follows:
0 = definite time
1 = IDMT

④ The H2 restraint variable is encoded as follows:
0 = H2 restraint
1 = no H2 restraint

⑤ The tripping curve setting is:
0 = definite time
1 = IDMT

⑥ Setting of latching and CB control
0 = No
1 = Yes

⑦ Tripping curve for negative sequence undercurrent:
0 = definite
7 = IEC SIT/A
8 = IEC LTI/B
9 = IEC VIT/B
10 = IEC EIT/C
11 = IEEE Mod. inverse
12 = IEEE Very inverse
13 = IEEE Extr. inverse
17 = Schneider specific

⑧ The activation of each of the cycles is encoded as follows:
Correspondence between bit position / protection according to the table below:

| Bit | Activation by |
|---|---|
| 0 | Instantaneous phase overcurrent, unit 1 |
| 1 | Time-delayed phase overcurrent, unit 1 |
| 2 | Instantaneous phase overcurrent, unit 2 |
| 3 | Time-delayed phase overcurrent, unit 2 |
| 4 | Instantaneous phase overcurrent, unit 3 |
| 5 | Time-delayed phase overcurrent, unit 3 |
| 6 | Instantaneous phase overcurrent, unit 4 |
| 7 | Time-delayed phase overcurrent, unit 4 |
| 8 | Instantaneous earth fault, unit 1 |
| 9 | Time-delayed earth fault, unit 1 |
| 10 | Instantaneous earth fault, unit 2 |
| 11 | Time-delayed earth fault, unit 2 |
| 12 | Instantaneous earth fault, unit 3 |
| 13 | Time-delayed earth fault, unit 3 |
| 14 | Instantaneous earth fault, unit 4 |
| 15 | Time-delayed earth fault, unit 4 |
| 16 | Instantaneous directional earth fault, unit 1 |
| 17 | Time-delayed directional earth fault, unit 1 |
| 18 | Instantaneous directional earth fault, unit 2 |
| 19 | Time-delayed directional earth fault, unit 2 |
| 20 | Instantaneous directional phase overcurrent, unit 1 |
| 21 | Time-delayed directional phase overcurrent, unit 1 |
| 22 | Instantaneous directional phase overcurrent, unit 2 |
| 23 | Time-delayed directional phase overcurrent, unit 2 |
| 24 | V_TRIPCB (logic equation) |

The bit status is encoded as follows:
0 = No activation by the protection function
1 = Activation by the protection function.

⑨ The time delay unit of the CLPU functions is coded the following way:
0 = millisecond
1 = second
2 = minute

## General settings

Function number: 3002

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Rated frequency | 0 = 50 Hz, 1 = 60 Hz |
| 2 | Remote setting enabled | 1 = disabled |
| 3 | Working language | 0 = English, 1 = other |
| 4 | Active group of settings | 0 = Group A<br>1 = Group B<br>3 = Choice by I13<br>4 = Choice by remote control |
| 5 | Setting mode | 0 = TMS, 1 = I/Is |
| 6 | Phase CT rating | 0 = 5 A, 1 = 1 A, 2 = LPCT |
| 7 | Number of phase CTs | 0 = 3 CTs, 1 = 2 CTs |
| 8 | Rated current In | A |
| 9 | Basic current Ib | A |
| 10 | Residual current determination mode | 0 = None<br>1 = 2 A CSH<br>2 = 20 A CSH<br>3 = 1 A CT<br>4 = 5 A CT<br>5 = ACE990 Range 1<br>6 = ACE990 Range 2<br>7 = 5 A CSH<br>8 = Sensitive 1 A CT<br>9 = Sensitive 5 A CT |
| 11 | Rated residual current (In0) | 0.1 A |
| 12 | Integration period | 0 = 5 mn, 1 = 10 mn<br>2 = 15 mn, 3 = 30 mn<br>4 = 60 mn |
| 13 | *Reserved* | |
| 14 | Rated primary voltage Unp | V |
| 15 | Rated secondary voltage Uns | 0 = 100 V, 1 = 110 V<br>2 = 115 V, 3 = 120 V<br>4 = 200 V, 5 = 230 V<br>6 = Numerical value,<br>see setting 21 |
| 16 | VT wiring | 0 = 3 V, 1 = 2 U, 2 = 1 U |
| 17 | Residual voltage mode | 0 = None 1 = Σ 3 V<br>2 = external VT – Uns/$\sqrt{3}$<br>3 = external VT – Uns/3 |
| 18 | Type of cubicle | 0 = incomer 1= feeder |
| 19 | Increment active power | 0.1 kW.h |
| 20 | Increment reactive power | 0.1 kvar.h |
| 21 | Rated secondary voltage Uns | V |

## Protection settings

They are organized according to increasing ANSI codes.

### ANSI 27/27S - Undervoltage

Function number: 10xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Voltage mode | 0 = phase-to-neutral,<br>1 = phase-to-phase |
| 7 | Us (or Vs) set point | % Unp (or Vnp) |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

### ANSI 27D - Positive sequence undervoltage

Function number: 08xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Vsd set point | % Unp |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

### ANSI 27R - Remanent undervoltage

Function number: 0901

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Us set point | % Unp |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

### ANSI 32P - Active overpower

Function number: 2301

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Type | 0 = reverse power<br>1 = overpower |
| 5 | *Reserved* | - |
| 6 | *Reserved* | - |
| 7 | Ps set point | 100 W |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

**ANSI 32Q - Reactive overpower**
Function number: 2401

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Type | 0 = reverse power<br>1 = overpower |
| 5 | *Reserved* | - |
| 6 | *Reserved* | - |
| 7 | Qs set point | 100 var |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

**ANSI 37 - Phase undercurrent**
Function number: 0501

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Is set point | % Ib |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

**ANSI 38/49T - Temperature monitoring**
Function number: 15xx
relay 1: xx = 01 to relay 16: xx = 10h

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Alarm set point | °C |
| 7 | Trip set point | °C |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

**ANSI 46 - Negative sequence / unbalance**
Function number: 03xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Tripping curve | ⑦ |
| 7 | Is set point | % Ib |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

**ANSI 46BC - Broken Conductor**
Function number: 2801

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Set point | % |
| 7 | Tripping time delay | 10 ms |

**ANSI 47 - Negative sequence overvoltage**
Function number: 1901

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Vsi set point | % Unp |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

**ANSI 48/51LR/14 - Locked rotor, excessive starting time**
Function number: 0601

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Is set point | % Ib |
| 7 | Excessive starting time delay | 10 ms |
| 8 | Locked rotor time delay | 10 ms |
| 9 | Locked rotor on start time delay | 10 ms |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | *Reserved* | - |

**ANSI 49RMS - Thermal overload**

Function number: 0401

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Negative sequence factor K | 0: without<br>1: low (2.25)<br>2: average (4.5)<br>3: high (9) |
| 5 | Current threshold Is (switching from rate 1/rate 2) | % Ib |
| 6 | Accounting for ambient temperature | 0: no<br>1: yes |
| 7 | Maximum equipment temperature | °C |
| 8 | Additional settings taken into account (rate 2) | 0: no<br>1: yes |
| 9 | Learnt cooling time constant (T2 learnt) taken into account | 0: no<br>1: yes |
| 10 | *Reserved* | |
| 11 | *Reserved* | |
| 12 | Rate 1 - heatrise alarm set point | % |
| 13 | Rate 1 - heatrise tripping set point | % |
| 14 | Rate 1 - heating time constant | mn |
| 15 | Rate 1 - cooling time constant | mn |
| 16 | Rate 1 - initial heatrise | % |
| 17 | *Reserved* | |
| 18 | *Reserved* | |
| 19 | *Reserved* | |
| 20 | *Reserved* | |
| 21 | *Reserved* | |
| 22 | Rate 2 - heatrise alarm set point | % |
| 23 | Rate 2 - heatrise tripping set point | % |
| 24 | Rate 2 - heating time constant | mn |
| 25 | Rate 2 - cooling time constant | mn |
| 26 | Rate 2 - initial heatrise | % |
| 27 | Rate 2 - base current for rate 2 | 0.1 A |
| 28 | *Reserved* | |
| 29 | *Reserved* | |
| 30 | *Reserved* | |
| 31 | *Reserved* | |

**ANSI 50/51 - Phase overcurrent**
Function number: 01xx
relay 1: xx = 01 to relay 4: xx = 04

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Confirmation | 0 = none,<br>1 = neg. seq. overvoltage,<br>2 = undervoltage |
| 5 | H2 restraint set point (1) | % |
| 6 | *Reserved* | - |
| 7 | Group A – tripping curve | ② |
| 8 | Group A – Is set point | 0.1 A |
| 9 | Group A – tripping time delay | 10 ms |
| 10 | Group A – timer hold curve | ③ |
| 11 | Group A – timer hold delay | 10 ms |
| 12 | Group A – H2 restraint | ① |
| 13 | Group A – Iscmin | 0.1 A |
| 14 | *Reserved* | - |
| 15 | *Reserved* | - |
| 16 | Group B – tripping curve | ② |
| 17 | Group B – Is set point | 0.1 A |
| 18 | Group B – tripping time delay | 10 ms |
| 19 | Group B – timer hold curve | ③ |
| 20 | Group B – timer hold delay | 10 ms |
| 21 | Group B – H2 restraint | ① |
| 22 | Group B – Iscmin | 0.1 A |
| 23 | *Reserved* | |
| 24 | *Reserved* | |

***(1)*** *Set point utilized by all the groups.*

**ANSI 50BF - Breaker failure**
Function number: 2001

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Use close position of circuit breaker | ⑥ |
| 7 | Is set point | 0.1 A |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

**ANSI 50N/51N - Earth fault**
Function number: 02xx
relay 1: xx = 01 to relay 4: xx = 04

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Type of I0 | 0 calculated, 1 measured |
| 5 | *Reserved* | - |
| 6 | *Reserved* | - |
| 7 | Group A – tripping curve | ② |
| 8 | Group A – Is0 set point | 0.1 A |
| 9 | Group A – tripping time delay | 10 ms |
| 10 | Group A – timer hold curve | ③ |
| 11 | Group A – timer hold delay | 10 ms |
| 12 | Group A – H2 restraint | 0 yes, 1 no |
| 13 | *Reserved* | - |
| 14 | *Reserved* | - |
| 15 | *Reserved* | - |
| 16 | *Reserved* | - |
| 17 | Group B – tripping curve | ② |
| 18 | Group B – Is0 set point | 0.1 A |
| 19 | Group B – tripping time delay | 10 ms |
| 20 | Group B – timer hold curve | ③ |
| 21 | Group B – timer hold delay | 10 ms |
| 22 | Group B – H2 restraint | 0 yes, 1 no |
| 23 | *Reserved* | - |
| 24 | *Reserved* | - |
| 25 | *Reserved* | - |
| 26 | *Reserved* | - |

**ANSI 51V - Voltage-restrained phase overcurrent**
Function number: 2501

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Tripping curve | ② |
| 7 | Is set point | 0.1 A |
| 8 | Tripping time delay | 10 ms |
| 9 | Timer hold curve | ③ |
| 10 | Timer hold delay | 10 ms |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | *Reserved* | - |
| 14 | *Reserved* | - |

**ANSI 59 - Overvoltage**
Function number: 11xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Voltage mode | 0 = phase-to-neutral<br>1 = phase-to-phase |
| 7 | Us (or Vs) set point | % Unp (or Vnp) |
| 8 | Tripping time delay | 10 ms |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |

**ANSI 59N - Neutral voltage displacement**
Function number: 12xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Vs0 set point | % Unp |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

**ANSI 66 - Starts per hour**
Function number: 0701

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Period of time | Hours |
| 7 | Total number of starts | 1 |
| 8 | Number of consecutive hot starts | 1 |
| 9 | Number of consecutive starts | 1 |
| 10 | Time delay between starts | Minutes |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | *Reserved* | - |
| 14 | *Reserved* | - |

**ANSI 67 - Directional phase overcurrent**
Function number: 21xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Group A – direction | 0 line, 1 busbar |
| 7 | Group A – characteristic angle | 0 = 30° angle<br>1 = 45° angle<br>2 = 60° angle |
| 8 | Group A – tripping logic | 0 = one out of three<br>1 = two out of three |
| 9 | Group A – tripping curve | ② |
| 10 | Group A – Is set point | 0.1 A |
| 11 | Group A – tripping time delay | 10 ms |
| 12 | Group A – timer hold curve | ③ |
| 13 | Group A – timer hold delay | 10 ms |
| 14 | *Reserved* | - |
| 15 | *Reserved* | - |
| 16 | *Reserved* | - |
| 17 | *Reserved* | - |
| 18 | Group B – direction | 0 line, 1 busbar |
| 19 | Group B – characteristic angle | 0 = 30° angle<br>1 = 45° angle<br>2 = 60° angle |
| 20 | Group B – tripping logic | 0: 1 on 3, 1: 2 on 3 |
| 21 | Group B – tripping curve | ② |
| 22 | Group B – Is set point | 0.1 A |
| 23 | Group B – tripping time delay | 10 ms |
| 24 | Group B – timer hold curve | ③ |
| 25 | Group B – timer hold delay | 10 ms |
| 26 | *Reserved* | - |
| 27 | *Reserved* | - |
| 28 | *Reserved* | - |
| 29 | *Reserved* | - |

**ANSI 67N/67NC - Directional earth fault**
Function number: 22xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | Type | 0 = projection<br>1 = directionalized |
| 5 | Type of I0 (Sum or Core balance CT) | 0 calculated, 1 measured |
| 6 | *Reserved* | - |
| 7 | *Reserved* | - |
| 8 | Group A – direction | 0 line, 1 busbar |
| 9 | Group A – types 1 and 2: characteristic angle | 0 = -45° angle<br>1 = 0° angle<br>2 = 15° angle<br>3 = 30° angle<br>4 = 45° angle<br>5 = 60° angle<br>6 = 90° angle |
| | Group A – type 3: limit 1 | 0 to 359° |
| 10 | Group A – type 1: sector | 2 = 76° sector<br>3 = 83° sector<br>4 = 86° sector |
| | Group A – type 3: limit 2 | 0 to 359° |
| 11 | Group A – tripping curve | ② |
| 12 | Group A – types 1 and 2: Is0 set point | 0.1 A |
| | Group A – type 3: Is0 set point | 0.01 A |
| 13 | Group A – tripping time delay | 10 ms |
| 14 | Group A – types 1 and 2: Vs0 | % Unp |
| | Group A – type 3: Vs0 | 0.1 % Unp |
| 15 | Group A – timer hold curve | ③ |
| 16 | Group A – timer hold delay | 10 ms |
| 17 | Group A – memory time | 10 ms |
| 18 | Group A – memory voltage | % Unp |
| 19 | *Reserved* | - |
| 20 | *Reserved* | - |
| 21 | *Reserved* | - |
| 22 | *Reserved* | - |
| 23 | Group B – direction | 0 line, 1 busbar |
| 24 | Group B – types 1 and 2: characteristic angle | 0 = -45° angle<br>1 = 0° angle<br>2 = 15° angle<br>3 = 30° angle<br>4 = 45° angle<br>5 = 60° angle<br>6 = 90° angle |
| | Group B – type 3: limit 1 | 0 to 359° |
| 25 | Group B – type 1: sector | 2 = 76° sector<br>3 = 83° sector<br>4 = 86° sector |
| | Group B – type 3: limit 2 | 0 to 359° |
| 26 | Group B – tripping curve | ② |
| 27 | Group B – types 1 and 2: Is0 set point | 0.1 A |
| | Group B – type 3: Is0 set point | 0.01 A |
| 28 | Group B – tripping time delay | 10 ms |
| 29 | Group B – types 1 and 2: Vs0 | % Unp |
| | Group B – type 3: Vs0 | 0.1 % Unp |
| 30 | Group B – timer hold curve | ③ |
| 31 | Group B – timer hold delay | 10 ms |
| 32 | Group B – memory time | 10 ms |
| 33 | Group B – memory voltage | % Unp |
| 34 | *Reserved* | - |
| 35 | *Reserved* | - |
| 36 | *Reserved* | - |
| 37 | *Reserved* | - |

**ANSI 79 - Recloser**
Function number: 1701

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Activity | ① |
| 2 | Number of cycles | 1 to 4 |
| 3 | Reclaim time | 10 ms |
| 4 | Safety time until ready | 10 ms |
| 5 | Dead time extension | ⑥ |
| 6 | Maximum waiting time | 10 ms |
| 7 | *Reserved* | - |
| 8 | *Reserved* | - |
| 9 | Cycle 1 activation mode | ⑧ |
| 10 | Cycle 1 dead time | 10 ms |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | Cycle 2, 3, 4 activation mode | ⑧ |
| 14 | Cycle 2 dead time | 10 ms |
| 15 | Cycle 3 dead time | 10 ms |
| 16 | Cycle 4 dead time | 10 ms |
| 17 | *Reserved* | - |
| 18 | *Reserved* | - |

**ANSI 81H - Overfrequency**
Function number: 13xx
relay 1: xx = 01, relay 2: xx = 02

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Fs set point | 0.1 Hz |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | Vs set point | % Unp |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | *Reserved* | - |

**ANSI 81L - Underfrequency**
Function number: 14xx
relay 1: xx = 01 to relay 4: xx = 04

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | Latching | ⑥ |
| 2 | CB control | ⑥ |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Fs set point | 0.1 Hz |
| 7 | Tripping time delay | 10 ms |
| 8 | Restraint | 0 none<br>1 on frequency variation |
| 9 | Vs set point | % Unp |
| 10 | Inhibited threshold | on frequency variation |
| 11 | *Reserved* | - |
| 12 | *Reserved* | - |
| 13 | *Reserved* | - |
| 14 | *Reserved* | - |

## CLPU 50/51 and CLPU 50N/51N protection settings

Function number: 2A01

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | *Reserved* | - |
| 2 | *Reserved* | - |
| 3 | *Reserved* | - |
| 4 | Time before activation Tcold | 10 ms |
| 5 | Pick-up threshold CLPUs | % In |
| 6 | *Reserved* | |
| 7 | CLPU 50/51 global action setting | 0 = blocking<br>1 = multiplication |
| 8 | Activation of ANSI 50/51 protection unit x: OFF or ON | (1) (2) |
| 9 | Unit 1 / Group A 50/51: unit of activation time delay T | (9) |
| 10 | Unit 1 / Group A 50/51: activation time delay T | (1) |
| 11 | Unit 1 / Group A 50/51: multiplying factor M | % Is |
| 12 | Unit 2 / Group A 50/51: unit of activation time delay T | (9) |
| 13 | Unit 2 / Group A 50/51: activation time delay T | (1) |
| 14 | Unit 2 / Group A 50/51: multiplying factor M | % Is |
| 15 | Unit 3 / Group A 50/51: unit of activation time delay T | (9) |
| 16 | Unit 3 / Group A 50/51: activation time delay T | (1) |
| 17 | Unit 3 / Group A 50/51: multiplying factor M | % Is |
| 18 | Unit 4 / Group A 50/51: unit of activation time delay T | (9) |
| 19 | Unit 4 / Group A 50/51: activation time delay T | (1) |
| 20 | Unit 4 / Group A 50/51: multiplying factor M | % Is |
| 21 | Unit 1 / Group B 50/51: unit of activation time delay T | (9) |
| 22 | Unit 1 / Group B 50/51: activation time delay T | (1) |
| 23 | Unit 1 / Group B 50/51: multiplying factor M | % Is |
| 24 | Unit 2 / Group B 50/51: unit of activation time delay T | (9) |
| 25 | Unit 2 / Group B 50/51: activation time delay T | (1) |
| 26 | Unit 2 / Group B 50/51: multiplying factor M | % Is |
| 27 | Unit 3 / Group B 50/51: unit of activation time delay T | (9) |
| 28 | Unit 3 / Group B 50/51: activation time delay T | (1) |
| 29 | Unit 3 / Group B 50/51: multiplying factor M | % Is |
| 30 | Unit 4 / Group B 50/51: unit of activation time delay T | (9) |
| 31 | Unit 4 / Group B 50/51: activation time delay T | (1) |
| 32 | Unit 4 / Group B 50/51: multiplying factor M | % Is |
| 33 | CLPU 50N/51N global action setting | 0 = blocking<br>1 = multiplication |
| 34 | Activation of ANSI 50N/51N protection unit x: OFF or ON | (1) (2) |
| 35 | Unit 1 / Group A 50N/51N: unit of activation time delay T0 | (9) |
| 36 | Unit 1 / Group A 50N/51N: activation time delay T0 | (1) |
| 37 | Unit 1 / Group A 50N/51N: multiplying factor M0 | % Is0 |
| 38 | Unit 2 / Group A 50N/51N: unit of activation time delay T0 | (9) |
| 39 | Unit 2 / Group A 50N/51N: activation time delay T0 | (1) |
| 40 | Unit 2 / Group A 50N/51N: multiplying factor M0 | % Is0 |
| 41 | Unit 3 / Group A 50N/51N: unit of activation time delay T0 | (9) |
| 42 | Unit 3 / Group A 50N/51N: activation time delay T0 | (1) |
| 43 | Unit 3 / Group A 50N/51N: multiplying factor M0 | % Is0 |
| 44 | Unit 4 / Group A 50N/51N: unit of activation time delay T0 | (9) |
| 45 | Unit 4 / Group A 50N/51N: activation time delay T0 | (1) |
| 46 | Unit 4 / Group A 50N/51N: multiplying factor M0 | % Is0 |
| 47 | Unit 1 / Group B 50N/51N: unit of activation time delay T0 | (9) |
| 48 | Unit 1 / Group B 50N/51N: activation time delay T0 | (1) |
| 49 | Unit 1 / Group B 50N/51N: multiplying factor M0 | % Is0 |
| 50 | Unit 2 / Group B 50N/51N: unit of activation time delay T0 | (9) |
| 51 | Unit 2 / Group B 50N/51N: activation time delay T0 | (1) |
| 52 | Unit 2 / Group B 50N/51N: multiplying factor M0 | % Is0 |
| 53 | Unit 3 / Group B 50N/51N: unit of activation time delay T0 | (9) |
| 54 | Unit 3 / Group B 50N/51N: activation time delay T0 | (1) |
| 55 | Unit 3 / Group B 50N/51N: multiplying factor M0 | % Is0 |
| 56 | Unit 4 / Group B 50N/51N: unit of activation time delay T0 | (9) |
| 57 | Unit 4 / Group B 50N/51N: activation time delay T0 | (1) |
| 58 | Unit 4 / Group B 50N/51N: multiplying factor M0 | % Is0 |

***(1)*** *numerical value, see setting of time delay unit T.*

***(2)*** *bit 0 : unit 1 group A activation*
*bit 1 : unit 2 group A activation*
*bit 2 : unit 3 group A activation*
*bit 3 : unit 4 group A activation*
*bit 4 : unit 1 group B activation*
*bit 5 : unit 2 group B activation*
*bit 6 : unit 3 group B activation*
*bit 7 : unit 4 group B activation*

## Other protection settings

### ANSI 21FL - Fault Locator

Function number : 2901

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | *Reserved* | - |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | Time delay T | Numerical value, see unit at setting 5 |
| 5 | Unit of time delay T | 0 = s<br>1 = mn |
| 6 | Location unit (1) | 0 = km<br>1 = miles |
| 7 | Positive sequence resistance of lines (Rdl) | mΩ/km |
| 8 | Positive sequence reactance of lines (Xdl) | mΩ/km |
| 9 | Zero sequence resistance of lines (R0l) | mΩ/km |
| 10 | Zero sequence reactance of lines (X0l) | mΩ/km |
| 11 | Positive sequence resistance of cables (Rdc) | mΩ/km |
| 12 | Positive sequence reactance of cables (Xdc) | mΩ/km |
| 13 | Zero sequence resistance of cables (R0c) | mΩ/km |
| 14 | Zero sequence reactance of cables (X0c) | mΩ/km |
| 15 | Percentage of cable | % |

(1) This parameter is only valid to display the settings 7 to 14 on the advanced UMI and SFT2841 software.

### ANSI 60 - CT supervision

Function number: 2601

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | *Reserved* | - |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Behavior on 46, 51N, 32P, 32Q functions | 0 none, 1 inhibition |
| 7 | Tripping time delay | 10 ms |
| 8 | *Reserved* | - |
| 9 | *Reserved* | - |
| 10 | *Reserved* | - |
| 11 | *Reserved* | - |

### ANSI 60FL - VT supervision

Function number: 2701

| Setting | Data | Format/Unit |
|---|---|---|
| 1 | *Reserved* | - |
| 2 | *Reserved* | - |
| 3 | Activity | ① |
| 4 | *Reserved* | - |
| 5 | *Reserved* | - |
| 6 | Check loss of 3 V/2 U | ⑥ |
| 7 | Test current | ⑥ |
| 8 | Use Vi, Ii criterion | ⑥ |
| 9 | Behavior on 27/27S, 27D, 32P, 32Q, 47, 51V, 59, 59N functions | 0 none, 1 inhibition |
| 10 | Behavior on 67 function | 0 non directional, 1 inhibition |
| 11 | Behavior on 67N function | 0 non directional, 1 inhibition |
| 12 | Vi set point | % Vn |
| 13 | Ii set point | % In |
| 14 | Time delay loss 3 V/ 2 U | 10 ms |
| 15 | Time delay Vi, Ii | 10 ms |
| 16 | *Reserved* | - |
| 17 | *Reserved* | - |
| 18 | *Reserved* | - |
| 19 | *Reserved* | - |

## Presentation

The disturbance recording function is used to record analog and logical signals during a time interval.
Sepam can store up to 19 records.
Each record comprises two files:
- configuration file with suffix .CFG
- data file with suffix .DAT.

The data of each record may be transferred via the Modbus link.
It is possible to transfer 1 to 19 records to a remote monitoring and control system. A record may be transferred as many times as possible, until it is overwritten by a new record.
If a record is made by Sepam while the oldest record is being transferred, the oldest record is stopped.
If a command (e.g. remote read or remote setting request) is carried out during the transfer of a disturbance recording record, the record in not disturbed.

**Time-setting**
Each record can be dated.
Time-setting of Sepam is described in the "Time-tagging of events" section.

## Transferring records

Transfer requests are made record by record. A configuration file and a data file are produced for each record.
The master sends the commands to:
- find out the characteristics of the records stored in an identification zone
- read the contents of the different files
- acknowledge each transfer
- reread the identification zone to ensure that the record still appears in the list of records available.

2 transfer zones are available:
- transfer zone 1
  - request frame: 2200h-2203h
  - identification zone: starting at 2204h
  - reply frame: starting at 2300h
- transfer zone 2
  - request frame: 2400h-2403h
  - identification zone: starting at 2404h
  - reply frame: starting at 2500h.

**Reading the identification zone**
Given the volume of data to be transmitted, the master must ensure that there are data to be recovered and prepare the exchanges when necessary.
The identification zone, described below, is read by the reading of N words starting at the address 2204h/2404h:
- 2 reserve words forced to 0
- size of record configuration files encoded in 1 word
- size of record data files encoded in 2 words
- number of records encoded in 1 word
- date of record 1 (least recent) encoded in 4 words (see format below)
- date of record 2 encoded in 4 words (see format below)
- ...
- date of record 19 (most recent) encoded in 4 words (see format below)
- 27 reserve words.

All of these data are consecutive.

**Reading the contents of the different files**
**Request frame**
The master makes the request by writing the date of the record to be transferred (function 16) in 4 words starting at the address 2200h.
It should be noted that requesting a new record amounts to stopping the transfers that are in progress. This is not the case for an identification zone transfer request.

**2200h/2400h**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O | O | O | O | O | O | O | O | Y | Y | Y | Y | Y | Y | Y | Y |
| O | O | O | O | M | M | M | M | O | O | O | D | D | D | D | D |
| O | O | O | H | H | H | H | H | O | O | mn | mn | mn | mn | mn | mn |
| ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms | ms |

**Y** - 1 byte for years: varies from 0 to 99 years.
The remote monitoring and control system must ensure that the year 00 is later than 99.
**M** - 1 byte for months: varies from 1 to 12.
**D** - 1 byte for days: varies from 1 to 31.
**H** - 1 byte for hours: varies from 0 to 23.
**mn** - 1 byte for minutes: varies from 0 to 59.
**ms** - 2 bytes for milliseconds: varies from 0 to 59999.

**Reply frame**
Reading of each portion of configuration and data file records by a 125-word read frame (function 3) starting at the address 2300h.

**2300h/2500h**

| B15 | B14 | B13 | B12 | B11 | B10 | B09 | B08 | B07 | B06 | B05 | B04 | B03 | B02 | B01 | B00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exchange number | | | | | | | | Number of usable bytes in the data zone | | | | | | | |
| ..... | | | | | | | | | | | | | | | |
| Data zone | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | |

Reading should always begin with the first word in the address zone (any other address triggers an exception reply "incorrect address").
The configuration and data files are read in their entirety in Sepam. They are transferred adjacently.

If the master requests more exchanges than necessary, the exchange number remains unchanged and the number of usable bytes is forced to 0. To guarantee data transfers, it is necessary to allow a response time of about 500 ms between each read operation at 2300h.
The first word transmitted is an exchange word. The exchange word comprises two fields:
■ the most significant byte contains the exchange number. It is initialized to zero after an energizing operation. It is incremented by 1 by Sepam each time a transfer takes place successfully. When it reaches the value FF, it automatically goes back to zero
■ the least significant byte contains the number of usable bytes in the data zone. It is initialized to zero after an energizing operation and must be different from FFh.
The exchange word may also have the following values:
■ **xxyy**: the number of usable bytes in the data zone yy must be different from FFh
■ **0000h**: no "read requeste frame" has yet been formulated.
This is especially the case when Sepam is energized.
The other words are not significant.
■ **FFFFh**: the "request frameé has been processed, but the results in the reply zone are not yet available.
It is necessary to repeat "reply frame" reading.
The other words are not significant.
The words that follow the exchange word make up the data zone.
SInce the configuration and data files are adjacent, a frame may contain the edn of the configuration and the beginning of the data file of a record.
It is up to the remote monitoring and control system software to reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the identification zone.

**Acknowledging a transfer**

To inform Sepam that a record block that it has just read has been received correctly, the master must write the number of the last exchange that it has carried out in the "exchange number" field and set the "number of usable bytes in the data zone" of the exchange word to zero.
Sepam only increments the exchange number if new acquisition bursts are present.

**Rereading the identification zone**

To ensure that the record has not been modified, during its transfer by a new record, the master rereads the contents of the identification zone and ensures that the date of the recovered record is still present.

# Reading Sepam identification

## Presentation

The "Read Device Identification" function is used to access in a standardized manner the information required to clearly identify a device.
The description is made up of a set of objects (ASCII character strings).
Sepam series 40 accepts the "read identification" function (conformity level 02).
For a complete description of the function, go to **www.modbus.org**. The description below covers a subset of the function, adapted to Sepam series 40.

## Implementation

### Request frame

The request frame is made of the following components.

| *Field* | *Size (bytes)* | |
|---|---|---|
| Slave number | 1 | |
| 43 (2Bh) | 1 | *Generic access function code* |
| 14 (0Eh) | 1 | *Read device identification* |
| 01 or 02 | 1 | *Type of read* |
| 00 | 1 | *Object number* |
| CRC16 | 2 | |

The type of read is used to select a simplified (01) or a standard (02) description.

### Reply frame

The reply frame is made of the following components.:

| *Field* | *Size (bytes)* | |
|---|---|---|
| Slave number | 1 | |
| 43 (2Bh) | 1 | *Generic access function code* |
| 14 (0Eh) | 1 | *Read device identification* |
| 01 or 02 | 1 | *Type of read* |
| 02 | 1 | *Conformity level* |
| 00 | 1 | *Continuation-frame flag (none for Sepam)* |
| 00 | 1 | *Reserved* |
| n | 1 | *Number of objects (according to read type)* |
| 0bj1 | 1 | *Number of first object* |
| lg1 | 1 | *Length first object* |
| txt1 | lg1 | *ASCII string of first object* |
| ..... | ... | |
| objn | 1 | *Number $n^{th}$ object* |
| lgn | 1 | *Length $n^{th}$ object* |
| txtn | lgn | *ASCII string of $n^{th}$ object* |
| CRC16 | 2 | |

### Exception frame

If an error occurs during request processing, a special exception frame is sent.

| *Field* | *Size (bytes)* | |
|---|---|---|
| Slave number | 1 | |
| 171 (ABh) | 1 | *Generic access exception (2Bh + 80h)* |
| 14 (0Eh) | 1 | *Read device identification* |
| 01 or 03 | 1 | *Type of error* |
| CRC16 | 2 | |

### Sepam series 40 identification

The objects making up the Sepam series 40 identification are listed below.

| Number | Type | Value |
|---|---|---|
| 0 | VendorName | "Merlin Gerin" or "Schneider Electric" |
| 1 | ProductCode | Application EAN13 code |
| 2 | MajorMinorRevision | Application version number (Vx.yy) |
| 3 | VendorURL | "www.schneider-electric.com" |
| 4 | ProductName | "Sepam series 40" |
| 5 | ModelName | Application name (e.g. "M41 Motor") |
| 6 | UserAppName | Sepam marking |

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**ACE909-2 RS 232/RS 485 converter** **258**

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**ECI850 IEC 61850 Sepam server** **262**

# Safety instructions
## Before starting

This page contains important safety instructions that must be followed precisely before attempting to install, repair, service or maintain electrical equipment. Carefully read and follow the safety instructions described below.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC, BURNS OR EXPLOSION**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Beware of potential hazards, wear personal protective equipment, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements can lead to personal injury as well as damage to electrical equipment or other property.
- Handling this product requires relevant expertise in the field of protection of electrical networks. Only competent people who have this expertise are allowed to configure and set up this product.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the relay is installed, disconnect all input and output wires to the relay. High voltage testing can damage electronic components contained in the Sepam unit.

**Failure to follow these instructions will result in death or serious injury.**

# Precautions

*We recommend that you follow the instructions given in this document for quick, correct installation of your Sepam unit:*

- *Equipment identification*
- *Assembly*
- *Connection of inputs, current, voltage and sensors*
- *Connection of power supply*
- *Checking prior to commissioning*

## Transport, handing and storage

**Sepam in its original packaging**

**Transport:**
Sepam can be shipped to any destination by all usual means of transport without taking any additional precautions.

**Handling:**
Sepam can be handled without any particular care and can even withstand being dropped by a person standing at floor-level.

**Storage:**
Sepam can be stored in its original packaging, in an appropriate location for several years:

- Temperature between -25°C and +70°C (between -13°F and +158°F)
- Humidity ⩽ 90%.

Periodic, yearly checking of the environment and the packaging condition is recommended.
Once Sepam has been unpacked, it should be energized as soon as possible.

**Sepam installed in a cubicle**

**Transport:**
Sepam can be transported by all usual means of transport in the customary conditions used for cubicles. Storage conditions should be taken into consideration for a long period of transport.

**Handling:**
Should the Sepam fall out of a cubicle, check its condition by visual inspection and energizing.

**Storage:**
Keep the cubicle protection packing for as long as possible. Sepam, like all electronic units, should not be stored in a damp environment for more than a month. Sepam should be energized as quickly as possible. If this is not possible, the cubicle reheating system should be activated.

## Environment of the installed Sepam

**Operation in a damp environment**
The temperature/relative humidity factors must be compatible with the unit's environmental withstand characteristics.
If the use conditions are outside the normal zone, special arrangements should be made before commissioning, such as air conditioning of the premises.

**Operation in a polluted atmosphere**
A contaminated industrial atmosphere (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents, etc.) can cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as pressurized premises with filtered air, etc.) before commissioning.
The effect of corrosion on Sepam has been tested according to the IEC 60068-2-60 and EIA 364-65A (See "Environmental Characteristic", page 18).

# Equipment identification
## Identification of the base unit

### Identification of the base unit

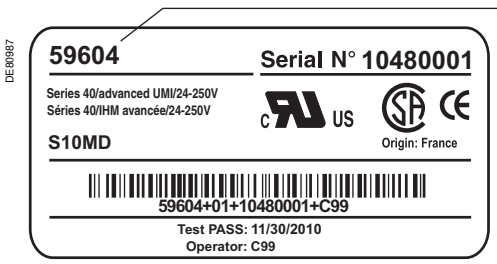
Each Sepam comes in a single package which contains the base unit and 2 connectors:

- 1 x 20-pin connector (CCA620 or CCA622)
- 1 x 6-pin connector (CCA626 or CCA627)

The other optional accessories such as modules, current input connectors or voltage and cords are supplied in separate packages.

To identify a Sepam, check the 2 labels on the right side panel of the base unit describing the product's functional and hardware features.

- Hardware reference and designation label




- Software reference and designation label

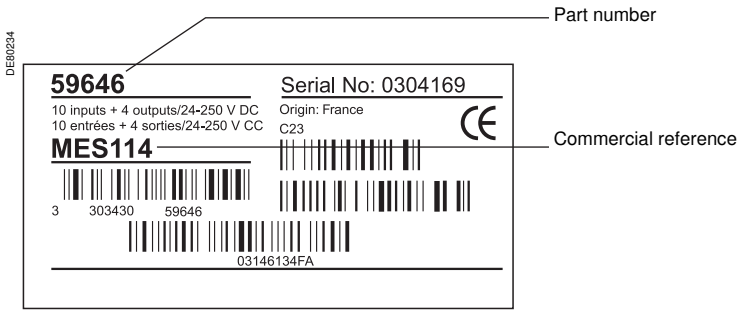
6

# Equipment identification
## Identification of accessories

### Identification of accessories

The accessories such as optional modules, current or voltage connectors and connection cords come in separate packages, which are identified by labels.

■ Example of MES114 module identification label:



# Equipment identification
Sepam series 40

## List of Sepam series 40 references

| Reference | Description |
|---|---|
| 59600 | Base unit with basic UMI, 24-250 V DC and 100-240 V AC power supply |
| 59604 | Base unit with advanced UMI, 24-250 V DC and 100-240 V AC power supply |
| 59608 | DSM303, remote advanced UMI module |
| | |
| 59615 | Working language English/French |
| 59616 | Working language English/Spanish |
| | |
| 59629 | CCA634 connector for 1 A/5 A CT + I0 current sensors |
| 59630 | CCA630 connector for 1 A/5 A CT current sensors |
| 59631 | CCA670 connector for LPCT current sensors |
| | |
| 59634 | CSH30 interposing ring CT for I0 input |
| 59635 | CSH120 residual current sensor, diameter 120 mm (4.75 in) |
| 59636 | CSH200 residual current sensor, diameter 200 mm (7.87 in) |
| 59638 | ECI850 IEC 61850 Sepam server with PRI voltage surge arrester |
| 59639 | AMT852 lead sealing accessory |
| | |
| 59641 | MET148-2 8-temperature sensor module |
| 59642 | ACE949-2 2-wire RS 485 network interface |
| 59643 | ACE959 4-wire RS 485 network interface |
| 59644 | ACE937 optical fiber interface |
| | |
| 59646 | MES114 10 input + 4 output module/24-250 V DC (1) |
| 59647 | MSA141 1 analog output module |
| 59648 | ACE909-2 RS 485/RS 232 converter |
| 59649 | ACE919CA RS 485/RS 485 interface (AC power supply) |
| 59650 | ACE919CC RS 485/RS 485 interface (DC power supply) |
| 59651 | MES114E 10 input + 4 output module/110-125 V DC and V AC |
| 59652 | MES114F 10 input + 4 output module/220-250 V DC and V AC |
| | |
| TCSEAK0100 | Ethernet configuration kit for ECI850 |

***(1)*** *Reference 59645 "MES108 module 4I/4O" cancelled and replaced by 59646.*

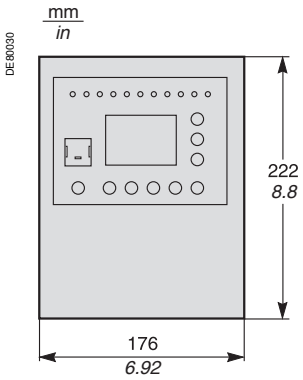
# Equipment identification
Sepam series 40

## List of Sepam series 40 references

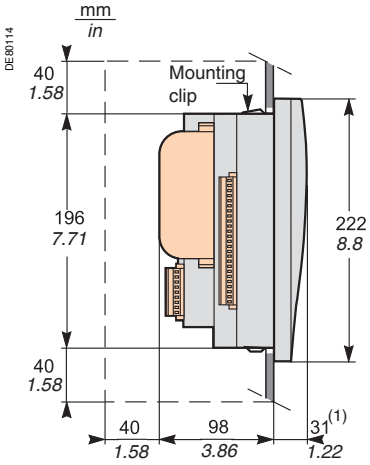
| | |
|---|---|
| 59656 | CCA626 6-pin screw type connector |
| 59657 | CCA627 6-pin ring lug connector |
| 59658 | ACE850TP RJ45 Ethernet multi-protocol interface (IEC 61850, Modbus TCP/IP) |
| 59659 | ACE850FO fiber-optic Ethernet multi-protocol interface (IEC 61850, Modbus TCP/IP) |
| 59660 | CCA770 remote module connection cord, L = 0.6 m (2 ft) |
| 59661 | CCA772 remote module connection cord, L = 2 m (6.6 ft) |
| 59662 | CCA774 remote module connection cord, L = 4 m (13.1 ft) |
| 59663 | CCA612 communication interface communication cord (except ACE850), L = 3 m (9.8 ft) |
| 59664 | CCA783 PC RS 232 port connection cord |
| | |
| 59666 | CCA613 LPCT test plug |
| 59667 | ACE917 LPCT injection adapter |
| 59668 | CCA620 20-pin screw type connector |
| 59669 | CCA622 20-pin ring lug connector |
| 59670 | AMT840 mounting plate |
| 59671 | CCA784 PC USB port connection cord |
| 59672 | ACE990 core balance CT interface for I0 input |
| | |
| 59676 | Kit 2640 2 sets of spare connectors for MES114 |
| | |
| 59679 | SFT2841 CD-ROM with SFT2841 and SFT2826 software, without CCA783 cord |
| 59680 | Substation application type S40 |
| 59681 | Substation application type S41 |
| 59682 | Substation application type S42 |
| 59683 | Transformer application type T40 |
| 59684 | Transformer application type T42 |
| 59685 | Motor application type M41 |
| 59686 | Generator application type G40 |
| 59687 | Substation application type S43 |
| 59688 | Substation application type S44 |
| 59689 | Motor application type M40 |
| | |
| 59723 | ACE969TP-2 2-wire RS 485 multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103) **(1)** |
| 59724 | ACE969FO-2 fiber-optic multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103) **(1)** |
| 59726 | CD SFT850 CD-ROM with IEC 61850 configuration software |
| | |
| 59751 | CCA614 ACE850 communication interface connection cord, L = 3 m (9.8 ft) |
| 59754 | TCP/IP firmware option (mandatory for using ACE850 multi-protocol communication interfaces with Sepam series 40, Sepam series 60 and Sepam series 80). |
| | |
| 59780 | Substation application type S50 |
| 59781 | Substation application type S51 |
| 59782 | Substation application type S52 |
| 59783 | Substation application type S53 |
| 59784 | Transformer application type T50 |
| 59785 | Transformer application type T52 |
| 59786 | Substation application type S54 |

***(1)** Reference 59720 "ACE969TP" cancelled and replaced by 59723, reference 59721 "ACE969FO" cancelled and replaced by 59724.*

## Dimensions

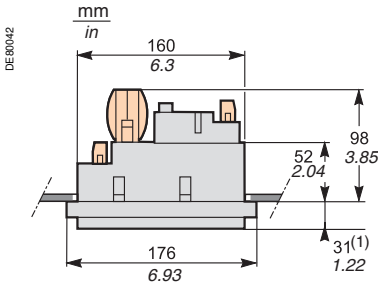



*Front view of Sepam.*




*Sepam with advanced UMI and MES114, flush-mounted in front panel.*

*Clearance for Sepam assembly and wiring.*



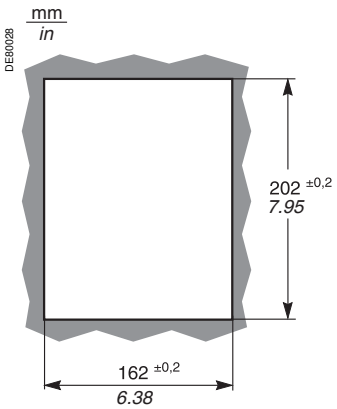

*Sepam with advanced UMI and MES114, flush-mounted in front panel.*

***(1)** With basic UMI: 23 mm (0.91 in).*

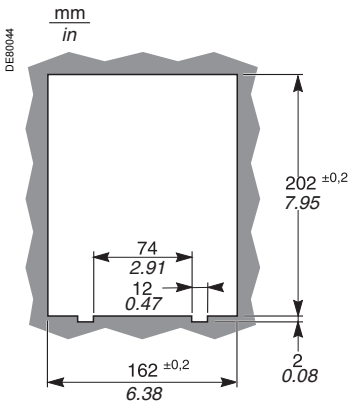
## Cut-out

Cut-out accuracy must be complied with to ensure good withstand.

**For mounting plate between 1.5 mm (0.059 in) and 3 mm (0.12 in) thick**




**For mounting plate 3.17 mm (0.125 inch) thick**




**⚠ CAUTION**

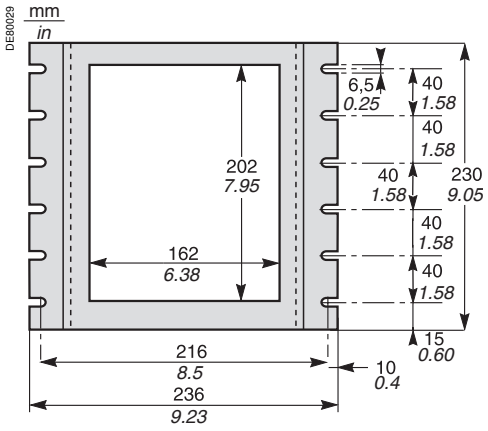
**HAZARD OF CUTS**

Trim the edges of the cut-out plates to remove any jagged edges.

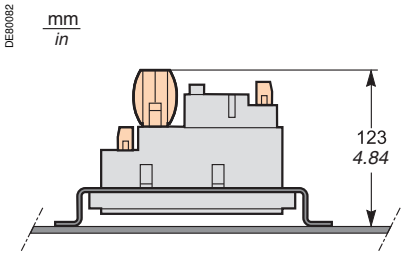
**Failure to follow these instructions can result in injury.**

## Assembly with AMT840 mounting plate

Used to mount Sepam with basic UMI at the back of the compartment with access to the connectors on the rear panel.
Mounting associated with the use of the remote advanced UMI (DSM303).




*AMT840 mounting plate.*




*Sepam with basic UMI and MES114, mounted with AMT840 plate.*
*Mounting plate thickness: 2 mm (0.079 in).*

# Base unit
## Assembly

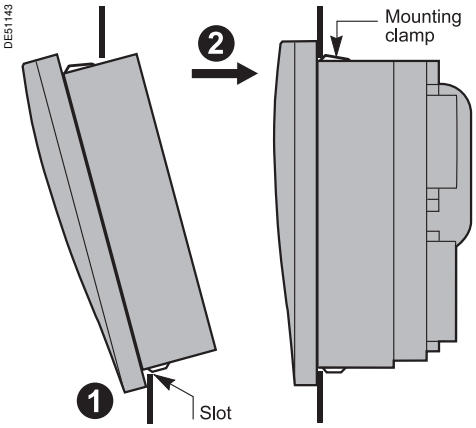
**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

**Failure to follow these instructions will result in death or serious injury.**

The Sepam is simply flush-mounted and secured by its clips. No additional screw type fastening is required.




(1) Present the product as indicated, making sure the metal plate is correctly entered in the groove at the bottom.

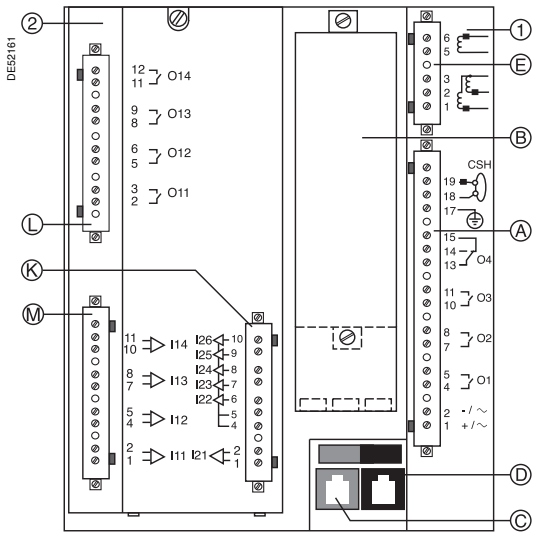
(2) Tilt the product and press on the top part to clamp it with the clips.

# Base unit
## Connection

### Sepam components

■ base unit ①
□ Ⓐ base unit connector:
- power supply
- output relay
- CSH30, 120, 200 or ACE990 input.

Screw-type connector shown (CCA620), or ring lug connector (CCA622)
□ Ⓑ 1/5 CT A current input connector (CCA630 or CCA634) or LPCT current input connector (CCA670)
□ Ⓒ communication module link connection (white)
□ Ⓓ remote inter-module link connection (black)
□ Ⓔ voltage input connection, screw-type connector shown (CCA626) or ring lug connector (CCA627)
■ optional input/output module ② (MES114)
□ Ⓛ Ⓜ MES114 module connectors
□ Ⓚ MES114 module connector.



# Base unit
Connection

### Connection of the base unit

The Sepam connections are made to the removable connectors located on the rear panel. All the connectors are screw-lockable.

**CAUTION**

**LOSS OF PROTECTION OR RISK OF NUISANCE TRIPPING**

If the Sepam is no longer supplied with power or is in fail-safe position, the protection functions are no longer active and all the Sepam output relays are dropped out. Check that this operating mode and the watchdog relay wiring are compatible with your installation.

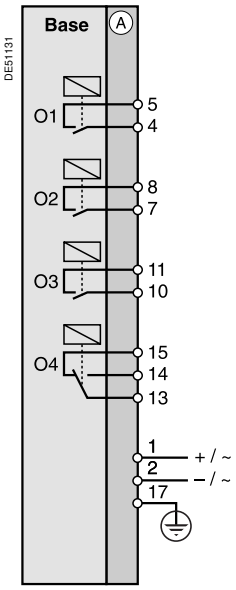
**Failure to follow these instructions can result in equipment damage and unwanted shutdown of the electrical installation.**

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

**Failure to follow these instructions will result in death or serious injury.**




**Wiring of connectors CCA620 and CCA626:**

- Without fitting:
  - 1 wire with maximum cross-section of 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm² (≥ AWG 24-16)
  - Stripped length: 8 to 10 mm (0.31 to 0.39 in)
- With fitting:
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 mm² (AWG 16)
    - DZ5CE025D for 1 wire 2.5 mm² (AWG 12)
    - AZ5DE010D for 2 wires 1 mm² (AWG 18)
  - Tube length: 8.2 mm (0.32 in)
  - Stripped length: 8 mm (0.31 in)

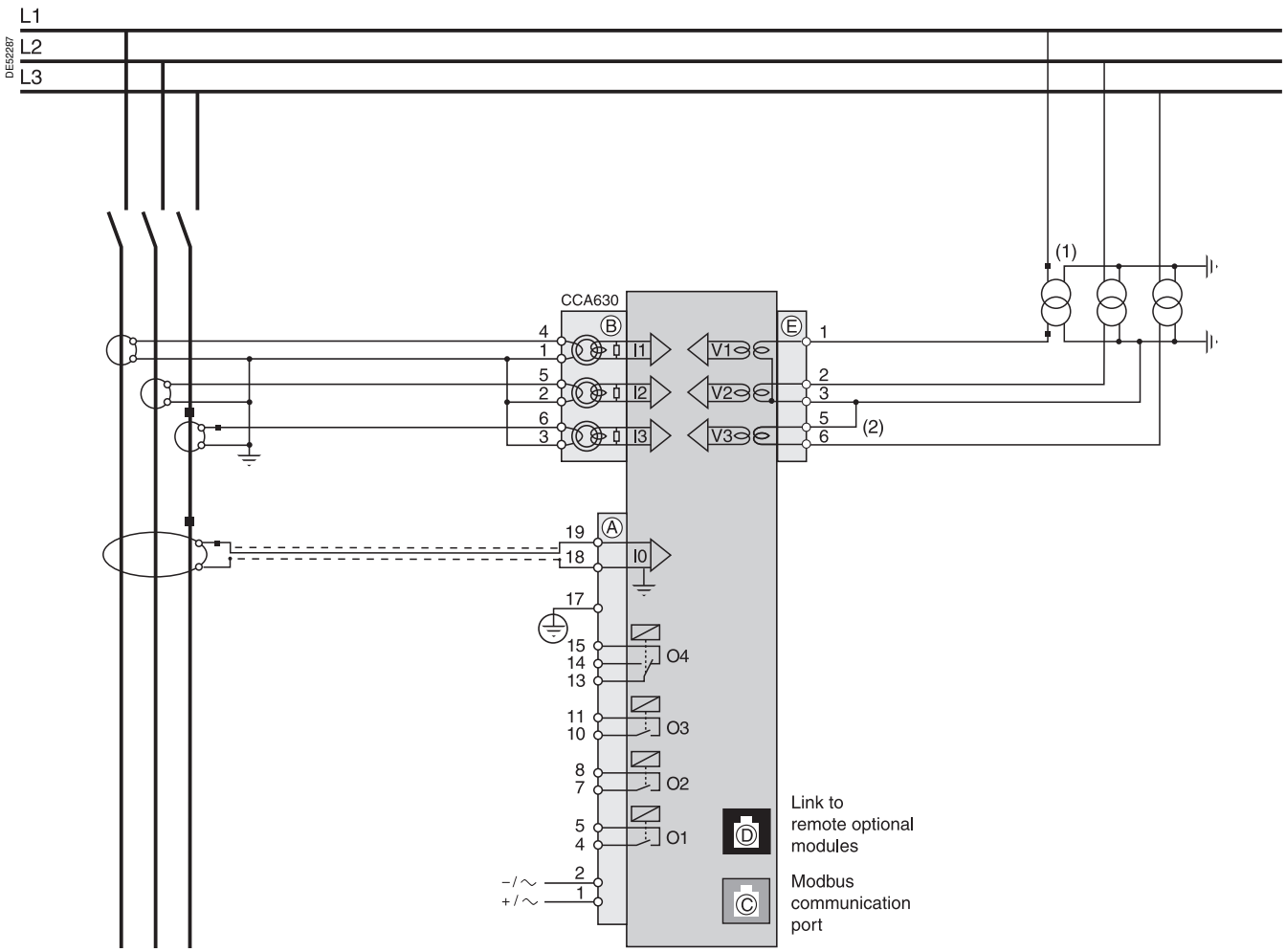
**Wiring of connectors CCA622 and CCA627:**

- Ring or spade lug: 6.35 mm (1/4")
- Wire with maximum cross-section 0.2 to 2.5 mm² (AWG 24-12)
- Stripped length: 6 mm (0.236 in)
- Use an appropriate tool to crimp the lugs onto the wires
- 2 ring or spade lugs maximum per terminal
- Tightening torque: 0.7 to 1 N•m (6 to 9 lb-in).

**Characteristics of the 4 base unit relay outputs O1, O2, O3, O4**

- O1 and O2 are 2 control outputs, used by the breaking device control function for:
  - O1: breaking device tripping
  - O2: breaking device closing inhibition
- O3 is a non assigned control output.
- O4 is a non assigned indication output. It can be assigned to the watchdog function.

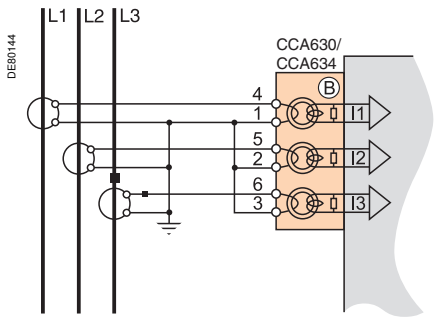
# Base unit
## Connection of current input




***(1)*** *This type of connection allows the calculation of residual voltage.*
***(2)*** *Accessory for bridging terminals 3 and 5 supplied with CCA626 connector.*

# Base unit
## Other phase current input connection schemes

### Variant 1: phase current measurements by 3 x 1 A or 5 A CTs (standard connection)



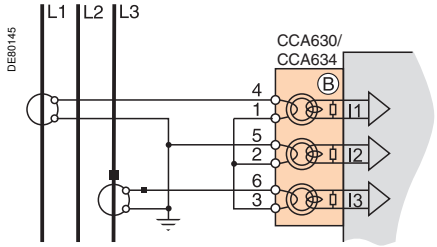

**Description**
Connection of 3 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

The measurement of the 3 phase currents allows the calculation of residual current.

**Parameters**

| | |
|---|---|
| Sensor type | 5 A CT or 1 A CT |
| Number of CTs | I1, I2, I3 |
| Rated current (In) | 1 A to 6250 A |

### Variant 2: phase current measurement by 2 x 1 A or 5 A CTs




**Description**
Connection of 2 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

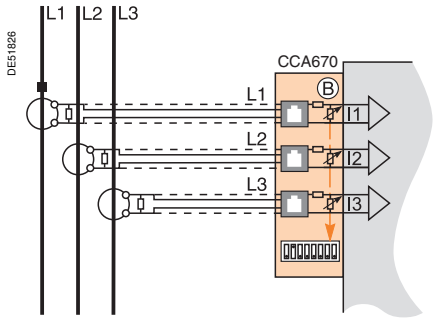
The measurement of phase currents 1 and 3 is sufficient to ensure all the phase current-based protection functions.
The phase current I2 is only assessed for metering functions, assuming that I0 = 0.

This arrangement does not allow the calculation of residual current.

**Parameters**

| | |
|---|---|
| Sensor type | 5 A CT or 1 A CT |
| Number of CTs | I1, I3 |
| Rated current (In) | 1 A to 6250 A |

### Variant 3: phase current measurement by 3 LPCT type sensors




**Description**
Connection of 3 Low Power Current Transducer (LPCT) type sensors to the CCA670 connector. The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into fail-safe position.

The measurement of the 3 phase currents allows the calculation of residual current.

**Parameters**

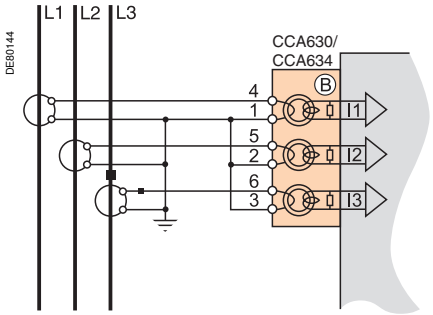
| | |
|---|---|
| Sensor type | LPCT |
| Number of CTs | I1, I2, I3 |
| Rated current (In) | 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000 or 3150 A |

***Note:*** *Parameter In must be set 2 twice:*

- *Software parameter setting using the advanced UMI or the SFT2841 software tool*
- *Hardware parameter setting using microswitches on the CCA670 connector*

# Base unit
## Other residual current input connection schemes

### Variant 1: residual current calculation by sum of 3 phase currents



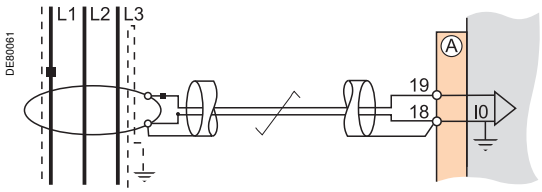

**Description**

Residual current is calculated by the vector sum of the 3 phase currents I1, I2 and I3, measured by 3 x 1 A or 5 A CTs or by 3 LPCT type sensors.
See current input connection diagrams, page 211.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| None | In0 = In, CT primary current | 0.1 to 40 In0 |

### Variant 2: residual current measurement by CSH120 or CSH200 core balance CT (standard connection)



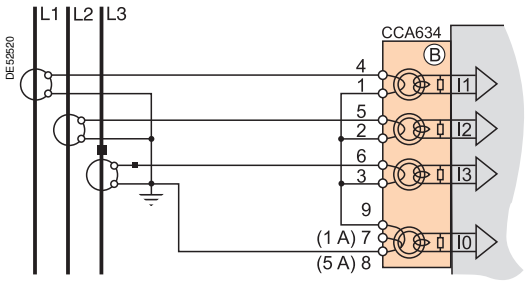

**Description**

Arrangement recommended for the protection of isolated or compensated neutral systems, in which very low fault currents need to be detected.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 2 A rating CSH | In0 = 2 A | 0.2 to 40 A |
| 5 A rating CSH | In0 = 5 A | 0.5 to 100 A |
| 20 A rating CSH | In0 = 20 A | 2 to 400 A |

### Variant 3: residual current measurement by 1 A or 5 A CTs and CCA634



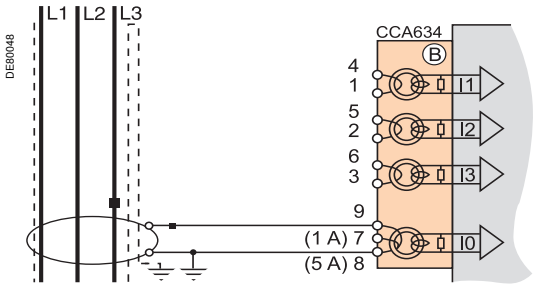

**Description**

Residual current measurement by 1 A or 5 A CTs.
- Terminal 7: 1 A CT
- Terminal 8: 5 A CT

The sensitivity can be multiplied by 10 using the "sensitive" parameter setting with In0 = In/10.

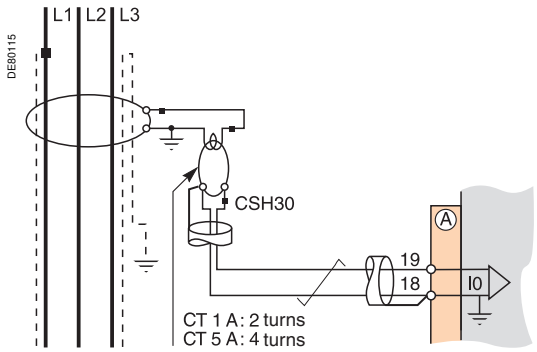
**Parameters**

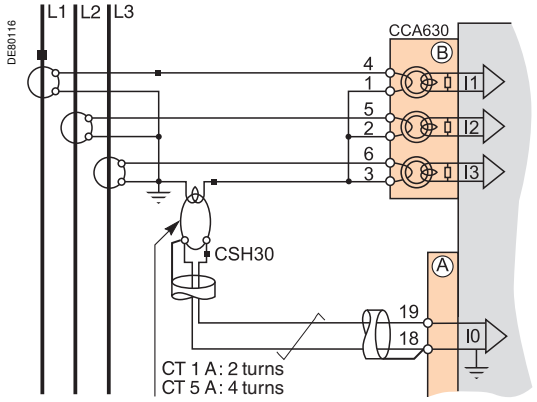
| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 1 A CT | In0 = In, CT primary current | 0.1 to 20 In0 |
| Sensitive 1 A CT | In0 = In/10 | 0.1 to 20 In0 |
| 5 A CT | In0 = In, CT primary current | 0.1 to 20 In0 |
| Sensitive 5 A CT | In0 = In/10 | 0.1 to 20 In0 |



# Base unit
## Other residual current input connection schemes

### Variant 4: residual current measurement by 1 A or 5 A CTs and CSH30 interposing ring CT




**Description**

The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to Sepam to measure residual current:

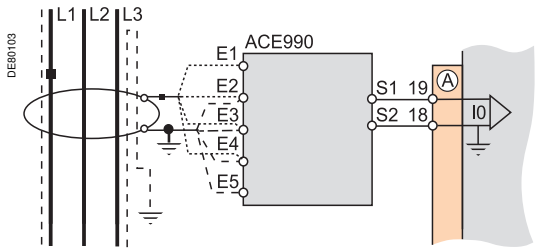
- Connection of CSH30 interposing ring CT to 1 A CT: make 2 turns through CSH primary
- Connection of CSH30 interposing ring CT to 5 A CT: make 4 turns through CSH primary.

The sensitivity can be multiplied by 10 using the "sensitive" parameter setting with In0 = In/10.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 1 A CT | In0 = In, CT primary current | 0.1 to 20 In0 |
| Sensitive 1 A CT | In0 = In/10 | 0.1 to 20 In0 |
| 5 A CT | In0 = In, CT primary current | 0.1 to 20 In0 |
| Sensitive 5 A CT | In0 = In/10 | 0.1 to 20 In0 |

### Variant 5: residual current measurement by core balance CT with ratio of 1/n (n between 50 and 1500)




**Description**

The ACE990 is used as an interface between an MV core balance CT with a ratio of 1/n
(50 < n < 1500) and the Sepam residual current input.
This arrangement allows the continued use of existing core balance CTs on the installation.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| ACE990 - range 1<br>(0.00578 ⩽ k ⩽ 0.04) | In0 = Ik.n(1) | 0.1 to 20 In0 |
| ACE990 - range 2<br>(0.0578 ⩽ k ⩽ 0.26316) | In0 = Ik.n(1) | 0.1 to 20 In0 |

***(1)*** *n = number of core balance CT turns*
*k = factor to be determined according to ACE990 wiring and setting range used by Sepam*

# Base unit
## Connection of low voltage residual current inputs

### Variant 1: residual current measurement by CTs on the neutral earthing link (with or without CSH30 interposing ring CT)

DE80103

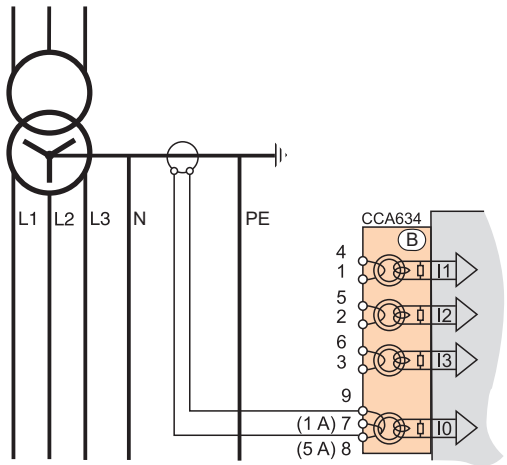
**Description**

Residual current is measured with a 1 A or 5 A CT on the neutral point.

**Parameters**

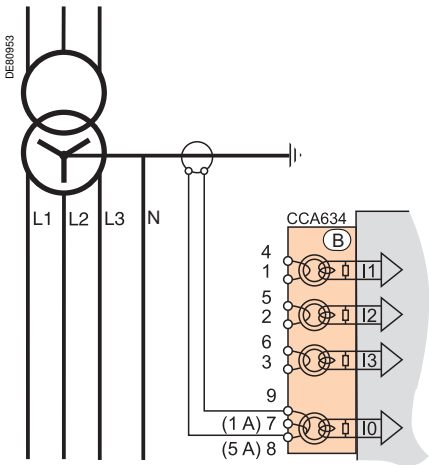
| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 1 A CT | In0 = neutral point CT In | 0.1 to 20 In0 |
| 5 A CT | In0 = neutral point CT In | 0.1 to 20 In0 |

DE80952



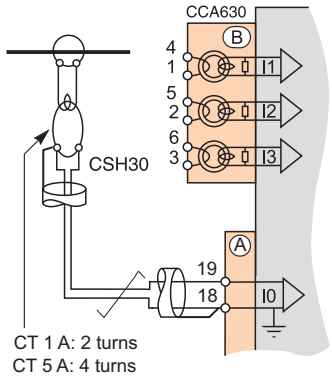

*Connection on TN-S network.*

DE80953




*Connection on TT network.*

DE81047




*Connection with CSH30.*

### Variant 2: residual current measurement by CSH120 or CSH200 core balance CT on the neutral earthing link

DE80103

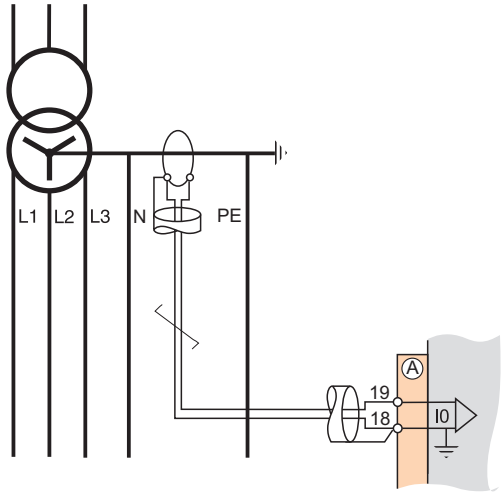
**Description**

Residual current is measured with a core balance CT on the neutral point. Core balance CTs are recommended for measuring very low fault currents provided that the earth fault current remains below 2 kA. Above this value it is advisable to use the standard variant 1.

**Parameters**

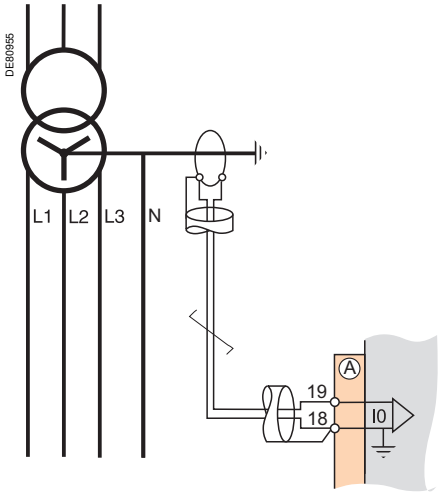
| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 2 A rating CSH | In0 = 2 A | 0.1 to 20 In0 |
| 5 A rating CSH | In0 = 5 A | 0.1 to 20 In0 |
| 20 A rating CSH | In0 = 20 A | 0.1 to 20 In0 |

DE80954




*Connection on TN-S network.*

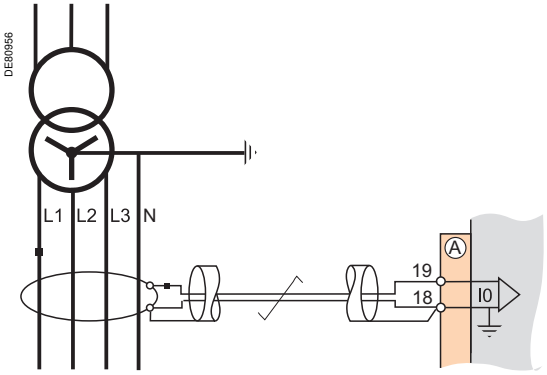
DE80955




*Connection on TT network.*

# Base unit
## Connection of low voltage residual current inputs

### Variant 3: residual current measurement by sum of 3 phase currents and neutral current measurement by CSH120 or CSH200 core balance CT




*Connection on TN-S and TT networks.*

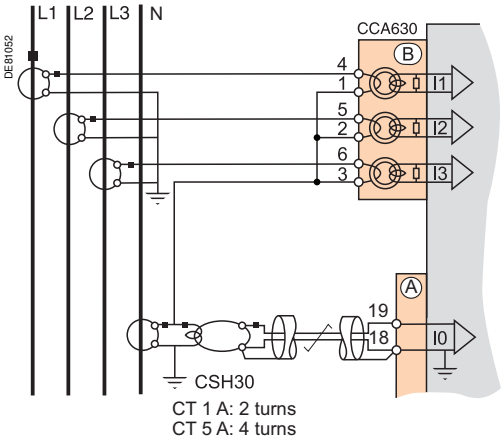
**Description**

Measurement by core balance CT is recommended for measuring very low fault currents.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 2 A rating CSH | In0 = 2 A | 0.1 to 20 In0 |
| 5 A rating CSH | In0 = 5 A | 0.1 to 20 In0 |
| 20 A rating CSH | In0 = 20 A | 0.1 to 20 In0 |

### Variant 4: residual current measurement by sum of 3 phase currents and neutral current measurement by 1 A or 5 A CTs and CSH30 interposing ring CT




*Connection on TN-S and TT networks.*

**Description**

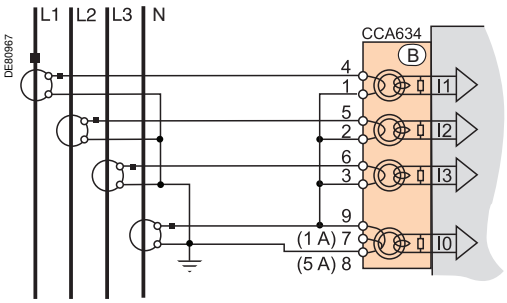
The phase and neutral CTs should have the same primary and secondary currents. The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to Sepam to measure residual current:

- Connection of CSH30 interposing ring CT to 1 A CT: make 2 turns through CSH primary
- Connection of CSH30 interposing ring CT to 5 A CT: make 4 turns through CSH primary.

**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 1 A CT | In0 = phase CT primary current In | 0.1 to 20 In0 |
| 5 A CT | In0 = phase CT primary current In | 0.1 to 20 In0 |

### Variant 5: residual current measurement by sum of 3 phase currents and neutral current measurement by 1 A or 5 A CTs and CCA634 connector




*Connection on TN-S and TT networks.*

**Description**

The phase and neutral CTs should have the same primary and secondary currents. Residual current measurement by 1 A or 5 A CTs.

- Terminal 7: 1 A CT
- Terminal 8: 5 A CT

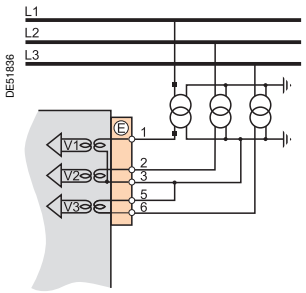
**Parameters**

| Residual current | Rated residual current | Measuring range |
|---|---|---|
| 1 A CT | In0 = phase CT primary current In | 0.1 to 20 In0 |
| 5 A CT | In0 = phase CT primary current In | 0.1 to 20 In0 |

# Base unit
## Connections of input voltage

The phase and residual voltage transformer secondary circuits are connected directly to the connector, item Ⓔ.
The 3 impedance matching and isolation transformers are integrated in the base unit of Sepam series 40.

### Variant 1: measurement of 3 phase-to-neutral voltages (standard connection)



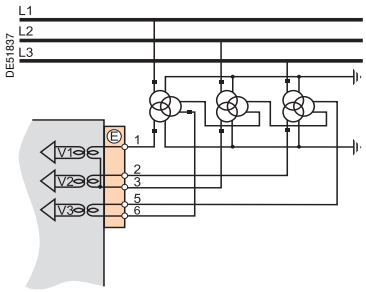

**Parameters**

| | |
|---|---|
| Voltages measured by VTs | V1, V2, V3 |
| Residual voltage | None |

**Functions available**

| | |
|---|---|
| Voltages measured | V1, V2, V3 |
| Values calculated | U21, U32, U13, V0, Vd, Vi, f |
| Measurements available | All |
| Protection functions available (according to type of Sepam) | All |

### Variant 2: measurement of 2 phase-to-phase voltages and residual voltage



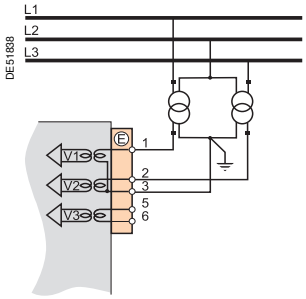

**Parameters**

| | |
|---|---|
| Voltages measured by VTs | U21, U32 |
| Residual voltage | External VT |

**Functions available**

| | |
|---|---|
| Voltages measured | U21, U32, V0 |
| Values calculated | U13, V1, V2, V3, Vd, Vi, f |
| Measurements available | All |
| Protection functions available (according to type of Sepam) | All |

### Variant 3: measurement of 2 phase-to-phase voltages



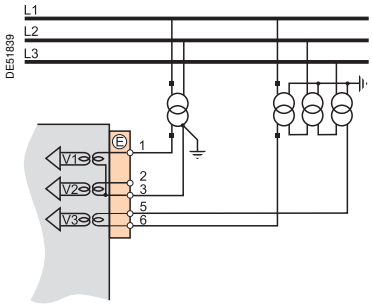

**Parameters**

| | |
|---|---|
| Voltages measured by VTs | U21, U32 |
| Residual voltage | None |

**Functions available**

| | |
|---|---|
| Voltages measured | U21, U32 |
| Values calculated | U13, Vd, Vi, f |
| Measurements available | U21, U32, U13, Vd, Vi, f |
| Protection functions available (according to type of Sepam) | All except 67N/67NC, 59N |

### Variant 4: measurement of 1 phase-to-phase voltage and residual voltage



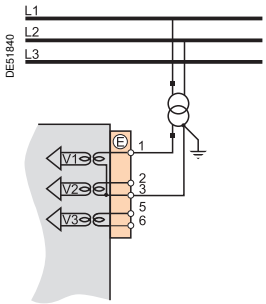

**Parameters**

| | |
|---|---|
| Voltages measured by VTs | U21 or V1 |
| Residual voltage | External VT |

**Functions available**

| | |
|---|---|
| Voltages measured | U21, V0 |
| Values calculated | f |
| Measurements available | U21, V0, f |
| Protection functions available (according to type of Sepam) | All except 67, 47, 27D,32P, 32Q/40, 27S |

### Variant 5: measurement of 1 phase-to-phase voltage




**Parameters**

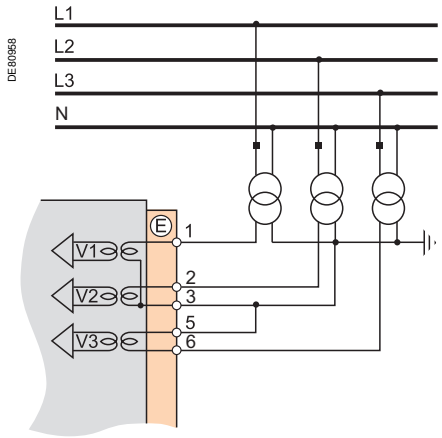
| | |
|---|---|
| Voltages measured by VTs | U21 or V1 |
| Residual voltage | None |

**Functions available**

| | |
|---|---|
| Voltages measured | U21 or V1 |
| Values calculated | f |
| Measurements available | U21 or V1, f |
| Protection functions available (according to type of Sepam) | All except 67, 47, 27D,32P, 32Q/40, 67N/67NC, 59N, 27S |

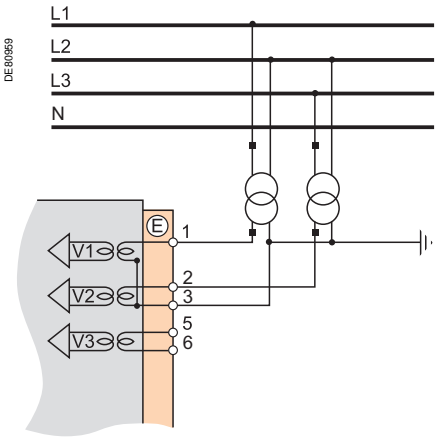
# Base unit
## Connection of low voltage phase voltage inputs

### Variant 1: TN-S and TN-C networks




When a ground fault occurs on a TN-S or TN-C network, the neutral potential is not affected: the neutral can act as a reference for the VTs.

### Variant 2: TT and IT networks




When a ground fault occurs on a TT or IT network, the neutral potential is affected: the neutral cannot act as a reference for the VTs, phase-to-phase voltages must be used on both phases.

# 1 A/5 A current transformers

ARJA1.

ARJP3.

## Function

Sepam may be connected to any standard 1 A and 5 A current transformer.
Schneider Electric offers a range of current transformers to measure primary currents from 50 A to 2500 A.
Please consult us for further information.

## Sizing of current transformers

Current transformers should be dimensioned so as not to become saturated by the current values they are required to measure accurately (minimum 5 In).

### For overcurrent protection

■ Definite time:
The saturation current must be more than 1.5 times the setting value.
■ IDMT:
The saturation current must be more than 1.5 times the highest working value on the curve.

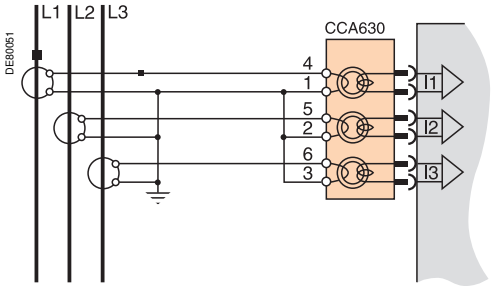
**Practical solution when there is no information on the settings**

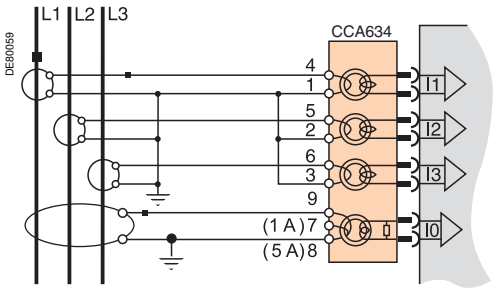
| Rated secondary current in | Rated burden | Accuracy class | CT secondary resistance RCT | Wiring resistance Rf |
|---|---|---|---|---|
| 1 A | 2.5 VA | 5P 20 | < 3 Ω | < 0.075 Ω |
| 5 A | 7.5 VA | 5P 20 | < 0.2 Ω | < 0.075 Ω |

## CCA630/CCA634 connector

### Function

The current transformers (1 A or 5 A) are connected to the CCA630 or CCA634 connector on the rear panel of Sepam:
■ The CCA630 connector is used to connect 3 phase current transformers to Sepam
■ The CCA634 connector is used to connect 3 phase current transformers and a residual current transformer to Sepam.
The CCA630 and CCA634 connectors contain interposing ring CTs with through primaries, which ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam when measuring phase and residual currents.
The connectors can be disconnected with the power on since disconnection does not open the CT secondary circuit.



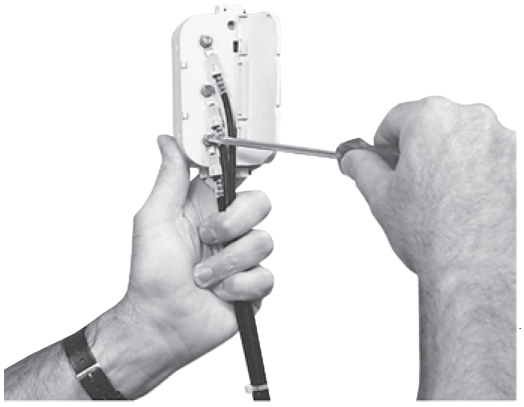

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

■ Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
■ NEVER work alone.
■ Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
■ Always use a properly rated voltage sensing device to confirm that all power is off.
■ To remove current inputs to the Sepam unit, unplug the CCA630 or CCA634 connector without disconnecting the wires from it. The CCA630 and CCA634 connectors ensure continuity of the current transformer secondary circuits.
■ Before disconnecting the wires connected to the CCA630 or CCA634 connector, short-circuit the current transformer secondary circuits.

**Failure to follow these instructions will result in death or serious injury.**

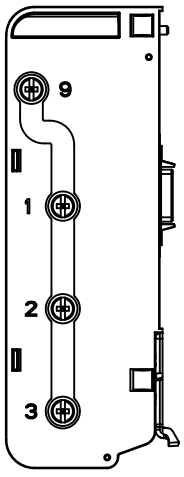
MT10490



## Connecting and assembling the CCA630 connector

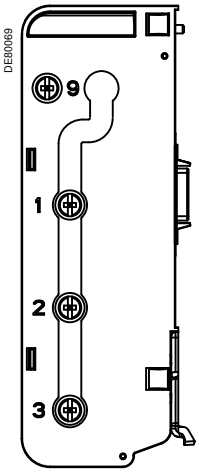
1. Open the 2 side shields for access to the connection terminals. The shields can be removed, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. If necessary, remove the bridging strap linking terminals 1, 2 and 3. This strap is supplied with the CCA630.
3. Connect the wires using 4 mm (0.16 in) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits.
The connector accommodates wires with cross-sections of 1.5 to 6 mm² (AWG 16-10).
4. Close the side shields.
5. Plug the connector into the 9-pin inlet on the rear panel (item Ⓑ).
6. Tighten the 2 CCA630 connector fastening screws on the rear panel of Sepam.

DE80068




*Bridging of terminals 1, 2, 3 and 9*

DE80069




*Bridging of terminals 1, 2 and 3*

## Connecting and assembling the CCA634 connector

1. Open the 2 side shields for access to the connection terminals. The shields can be removed, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. According to the wiring required, remove or reverse the bridging strap. This is used to link either terminals 1, 2 and 3, or terminals 1, 2, 3 and 9 (see picture opposite).
3. Use terminal 7 (1 A) or 8 (5 A) to measure the residual current according to the CT secondary.
4. Connect the wires using 4 mm (0.16 in) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits.
The connector accommodates wires with cross-sections of 1.5 to 6 mm² (AWG 16-10).
The wires only exit from the base.
5. Close the side shields.
6. Insert the connector pins into the slots on the base unit.
7. Flatten the connector against the unit to plug it into the 9-pin SUB-D connector (principle similar to that of the MES module).
8. Tighten the mounting screw.

## CAUTION

**HAZARD OF IMPROPER OPERATION**

Do not use a CCA634 on connector B1 and residual current input I0 on connector A (terminals 18 and 19) simultaneously.
Even if it is not connected to a sensor, a CCA634 will disturb input I0 on connector A.

**Failure to follow these instructions can result in equipment damage.**

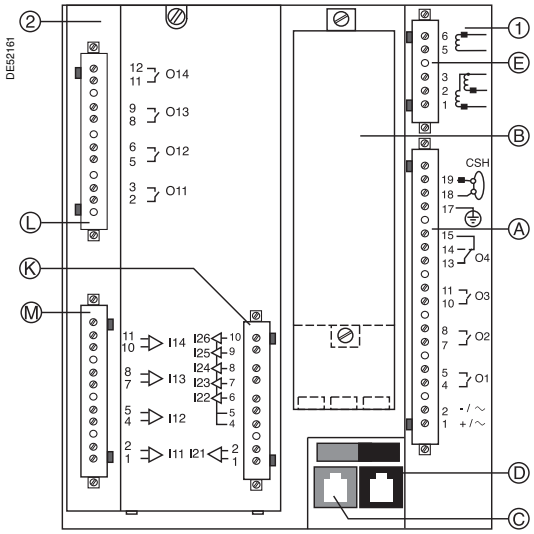
**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

**Failure to follow these instructions will result in death or serious injury.**

The phase and residual voltage transformer secondary circuits are connected to the connector, item Ⓔ.




## Connections

Connections are made using the screw connectors (CCA626) or ring lug connectors (CCA627) that can be accessed on the rear panel.

**Wiring of the CCA626 connector:**

- Without fitting:
  - 1 wire with maximum cross-section of 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm² (≥ AWG 24-16)
  - Stripped length: 8 to 10 mm (0.31 to 0.39 in)
- With fitting:
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 mm² (AWG 16)
    - DZ5CE025D for 1 wire 2.5 mm² (AWG 12)
    - AZ5DE010D for 2 wires 1 mm² (AWG 18)
  - Tube length: 8.2 mm (0.32 in)
  - Stripped length: 8 mm (0.31 in)

**Wiring of the CCA627 connector:**

- Ring or spade lug: 6.35 mm (1/4")
- Wire with maximum cross-section 0.2 to 2.5 mm² (AWG 24-12)
- Stripped length: 6 mm (0.236 in)
- Use an appropriate tool to crimp the lugs onto the wires
- 2 ring or spade lugs maximum per terminal
- Tightening torque: 0.7 to 1 N•m (6 to 9 lb-in).

# LPCT type current sensors

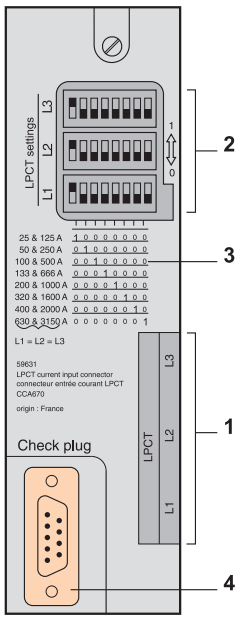
PE50031

*CLP1 LPCT sensor*

## Function

Low Power Current Transducer (LPCT) type sensors are voltage-output sensors, which are compliant with the IEC 60044-8 standard.
The Schneider Electric range of LPCTs includes the following sensors: CLP1, CLP2, CLP3, TLP130, TLP160 and TLP190.

DE51674




## CCA670/CCA671 connector

### Function

The 3 LPCT sensors are connected to the CCA670 or CCA671 connector on the rear panel of Sepam.
The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into fail-safe position.
The two CCA670 and CCA671 interface connectors serve the same purpose, the difference being the position of the LPCT sensor plugs:
- CCA670: lateral plugs, for Sepam series 20 and Sepam series 40
- CCA671: radial plugs, for Sepam series 60 and Sepam series 80.

### Description

**1** 3 RJ45 plugs to connect the LPCT sensors.
**2** 3 blocks of microswitches to set the CCA670/CCA671 to the rated phase current value.
**3** Microswitch setting/selected rated current equivalency table (2 In values per position).
**4** 9-pin sub-D connector to connect test equipment (ACE917 for direct connector or via CCA613).

### Rating of CCA670/CCA671 connectors

The CCA670/CCA671 connector must be rated according to the rated primary current In measured by the LPCT sensors. In is the current value that corresponds to the rated secondary current of 22.5 mV. The possible settings for In are (in A): 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.
The selected In value should be:
- entered as a Sepam general setting
- configured by microswitch on the CCA670/CCA671 connector.

Operating mode:
1. Use a screwdriver to remove the shield located in the "LPCT settings" zone; the shield protects 3 blocks of 8 microswitches marked L1, L2, L3.
2. On the L1 block, set the microswitch for the selected rated current to "1" (2 In values per microswitch).
- The table of equivalencies between the microswitch settings and the selected rated current In is printed on the connector
- Leave the 7 other microswitches set to "0".

3. Set the other 2 blocks of switches L2 and L3 to the same position as the L1 block and close the shield.

## CAUTION

**HAZARD OF NON-OPERATION**
- Set the microswitches for the CCA670/CCA671 connector before commissioning the device.
- Check that only one microswitch is in position 1 for each block L1, L2, L3 and that no microswitch is in the center position.
- Check that the microswitch settings on all 3 blocks are identical.

**Failure to follow these instructions can result in equipment damage.**

# LPCT type current sensors
Test accessories

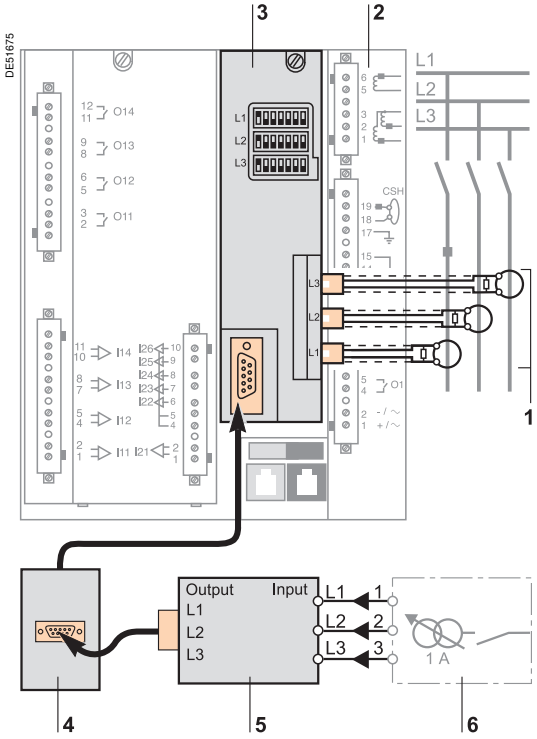
## Accessory connection principle

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

**Failure to follow these instructions will result in death or serious injury.**




**1** LPCT sensor, equipped with a shielded cable fitted with a yellow RJ 45 plug which is plugged directly into the CCA670/CCA671 connector.

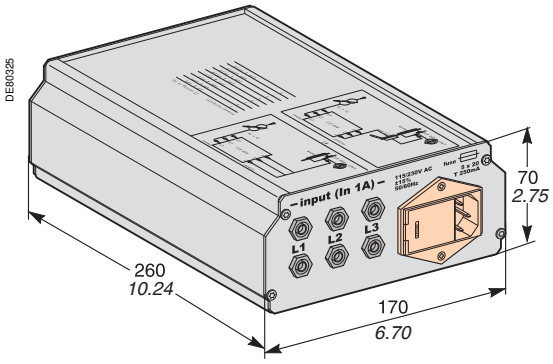
**2** Sepam protection unit.

**3** CCA670/CCA671 connector, LPCT voltage interface, with microswitch setting of rated current:
- CCA670: lateral plugs for Sepam series 20 and Sepam series 40
- CCA671: radial plugs for Sepam series 60 and Sepam series 80.

**4** CCA613 remote test plug, flush-mounted on the front of the cubicle and equipped with a 3-meter (9.8 ft) cord to be plugged into the test plug of the CCA670/ CCA671 interface connector (9-pin sub-D).

**5** ACE917 injection adapter, to test the LPCT protection chain with a standard injection box.

**6** Standard injection box.




## ACE917 injection adapter

### Function

The ACE917 adapter is used to test the protection chain with a standard injection box, when Sepam is connected to LPCT sensors.
The ACE917 adapter is inserted between:

- The standard injection box
- The LPCT test plug:
  - integrated in the Sepam CCA670/CCA671 interface connector
  - or transferred by means of the CCA613 accessory.

The following are supplied with the ACE917 injection adapter:

- Power supply cord
- 3-meter (9.8 ft) cord to connect the ACE917 to the LPCT test plug on CCA670/CCA671 or CCA613.

### Characteristics

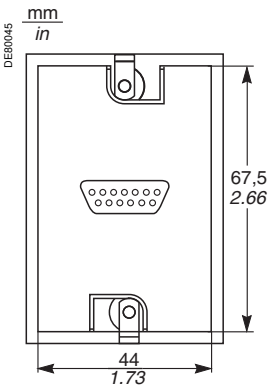
| | |
|---|---|
| Power supply | 115/230 V AC |
| Protection by time-delayed fuse 5 mm x 20 mm (0.2 x 0.79 in) | 0.25 A rating |

## CCA613 remote test plug

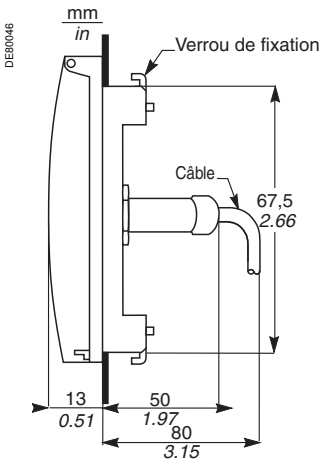
### Function

The CCA613 test plug, flush-mounted on the front of the cubicle, is equipped with a 3-meter (9.8 ft) cord to transfer data from the test plug integrated in the CCA670/ CCA671 interface connector on the rear panel of Sepam.

### Dimensions




*Front view with cover lifted.*

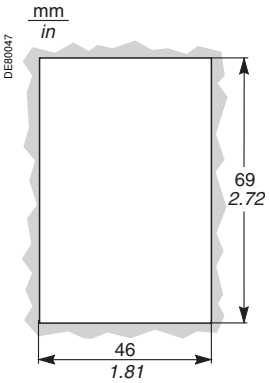



*Right side view.*

**⚠ CAUTION**

**HAZARD OF CUTS**
Trim the edges of the cut-out plates to remove any jagged edges.

**Failure to follow these instructions can result in injury.**




*Cut-out.*

# CSH120 and CSH200 Core balance CTs

PE50032

*CSH120 and CSH200 core balance CTs.*

## Function

The specifically designed CSH120 and CSH200 core balance CTs are for direct residual current measurement. The only difference between them is the diameter. Due to their low voltage insulation, they can only be used on cables.

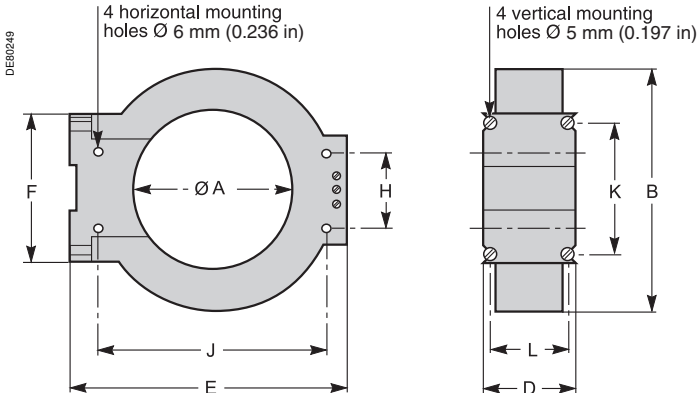
***Note:*** *The CSH280 core balance CT available in the Motorpact offer is compatible with Sepam.*

## Characteristics

| | | CSH120 | CSH200 |
|---|---|---|---|
| Inner diameter | | 120 mm (4.7 in) | 196 mm (7.72 in) |
| Weight | | 0.6 kg (1.32 lb) | 1.4 kg (3.09 lb) |
| Accuracy | 1 CT | ±5% at 20°C (68°F) | |
| | | ±6% max. from -25°C to 70°C (-13°F to +158°F) | |
| | 2 CTs in parallel | - | ±10% |
| Transformation ratio | | 1/470 | |
| Maximum permissible current | 1 CT | 20 kA - 1 s | |
| | 2 CTs in parallel | - | 6 kA - 1 s |
| Operating temperature | | -25°C to +70°C (-13°F to +158°F) | |
| Storage temperature | | -40°C to +85°C (-40°F to +185°F) | |

## Dimensions

DE80249




| Dimensions | A | B | D | E | F | H | J | K | L |
|---|---|---|---|---|---|---|---|---|---|
| **CSH120 (in)** | 120 (4.75) | 164 (6.46) | 44 (1.73) | 190 (7.48) | 80 (3.15) | 40 (1.57) | 166 (6.54) | 65 (2.56) | 35 (1.38) |
| **CSH200 (in)** | 196 (7.72) | 256 (10.1) | 46 (1.81) | 274 (10.8) | 120 (4.72) | 60 (2.36) | 254 (10) | 104 (4.09) | 37 (1.46) |

# CSH120 and CSH200 Core balance CTs

## ⚠ DANGER

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Only CSH120, CSH200 and CSH280 core balance CTs can be used for direct residual current measurement. Other residual current sensors require the use of an intermediate device, CSH30, ACE990 or CCA634.
- Install the core balance CTs on insulated cables.
- Cables with a rated voltage of more than 1000 V must also have an earthed shielding.

**Failure to follow these instructions will result in death or serious injury.**

## CAUTION

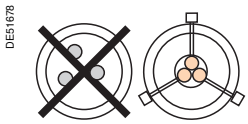
**HAZARD OF NON-OPERATION**

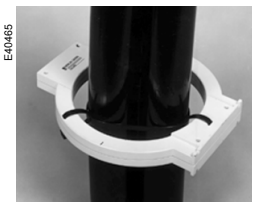
Do not connect the secondary circuit of the CSH core balance CTs to earth.
This connection is made in Sepam.

**Failure to follow these instructions can result in equipment damage.**

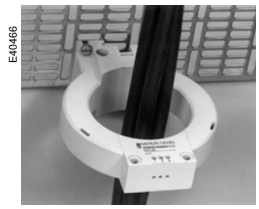
## Assembly

Group the MV cable (or cables) in the middle of the core balance CT.
Use non-conductive binding to hold the cables.
Remember to insert the 3 medium voltage cable shielding earthing cables through the core balance.




*Assembly on MV cables.*




*Assembly on mounting plate.*

## Connection

**Connection to Sepam series 20 and Sepam series 40**

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

**Connection to Sepam series 80**

To residual current I0 input, on connector (E), terminals 15 and 14 (shielding).

**Connection to Sepam series 60**

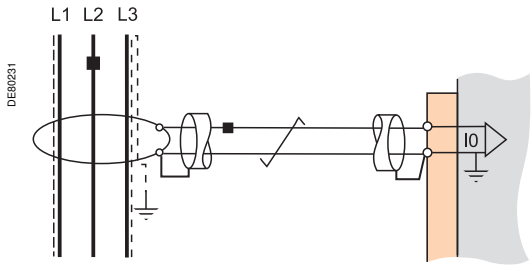
- To residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

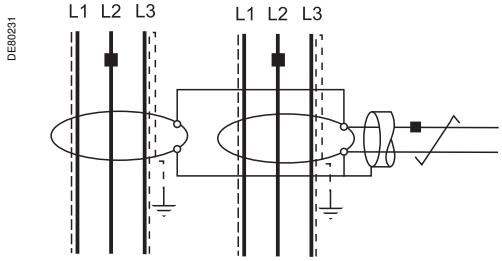
**Recommended cable**

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section 0.93 mm² (AWG 18)
- Resistance per unit length < 100 mΩ/m (30.5 mΩ/ft)
- Minimum dielectric strength: 1000 V (700 Vrms)
- Connect the cable shielding in the shortest manner possible to Sepam
- Flatten the connection cable against the metal frames of the cubicle.

The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.

**The maximum resistance of the Sepam connection wiring must not exceed 4 Ω (i.e. 20 m maximum for 100 mΩ/m or 66 ft maximum for 30.5 mΩ/ft).**




**Connecting 2 CSH200 CTs in parallel**

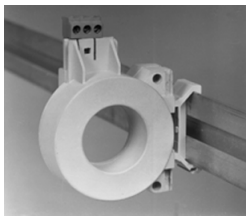
It is possible to connect 2 CSH200 CTs in parallel if the cables will not fit through a single CT, by following the instructions below:

- Fit one CT per set of cables.
- Make sure the wiring polarity is correct.

The maximum permissible current at the primary is limited to 6 kA - 1 s for all cables.

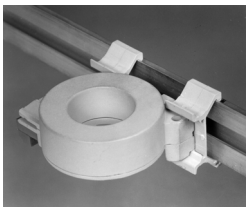
# CSH30 interposing ring CT

E40468



*Vertical assembly of CSH30 interposing ring CT.*

E44717



*Horizontal assembly of CSH30 interposing ring CT.*

## Function

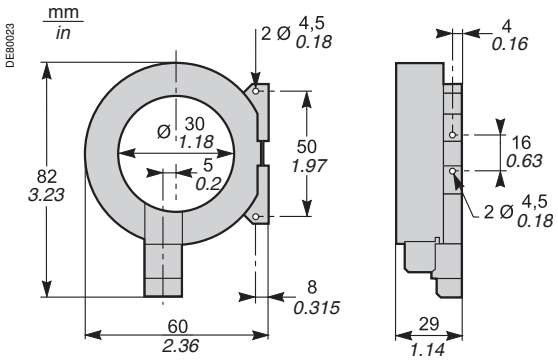
The CSH30 interposing ring CT is used as an interface when the residual current is measured using 1 A or 5 A current transformers.

## Characteristics

| | |
|---|---|
| Weight | 0.12 kg (0.265 lb) |
| Assembly | On symmetrical DIN rail<br>In vertical or horizontal position |

## Dimensions

DE80023




6

# CSH30 interposing ring CT

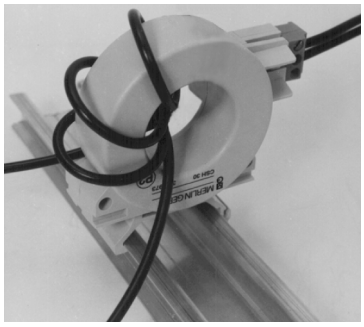
## Connection

The CSH30 is adapted for the type of current transformer, 1 A or 5 A, by the number of turns of the secondary wiring through the CSH30 interposing ring CT:

- 5 A rating - 4 turns
- 1 A rating - 2 turns

**Connection to 5 A secondary circuit**

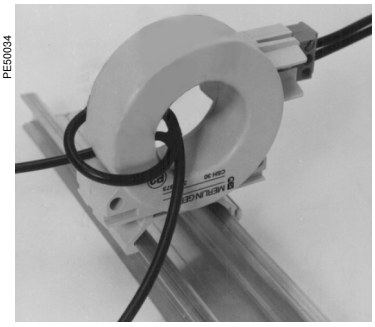
PE50033



1. Plug into the connector.
2. Insert the transformer secondary wire through the CSH30 interposing ring CT 4 times.

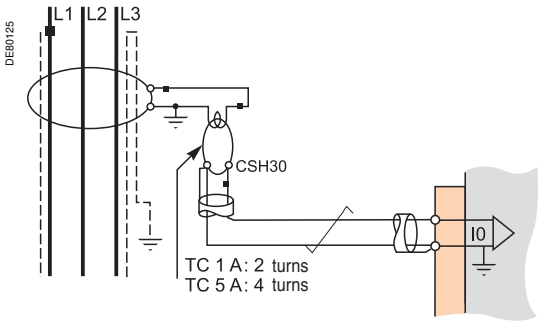
**Connection to 1 A secondary circuit**

PE50034



1. Plug into the connector.
2. Insert the transformer secondary wire through the CSH30 interposing ring CT twice.

DE80125




**Connection to Sepam series 20 and Sepam series 40**

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

**Connection to Sepam series 60**

To residual current I0 input, on connector (E) terminals 15 and 14 (shielding).

**Connection to Sepam series 80**

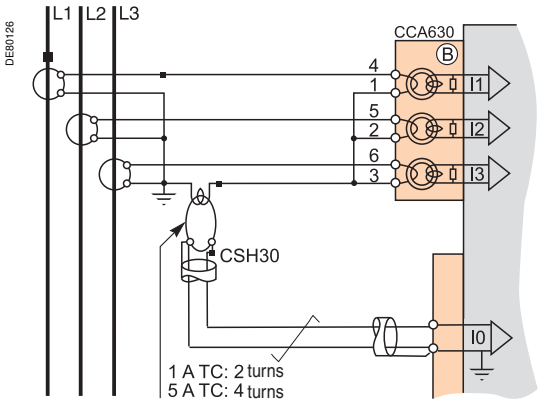
- To residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

**Recommended cable**

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section 0.93 mm² (AWG 18) (max. 2.5 mm², AWG 12)
- Resistance per unit length < 100 mΩ/m (30.5 mΩ/ft)
- Minimum dielectric strength: 1000 V (700 Vrms)
- Maximum length: 2 m (6.6 ft).

It is essential for the CSH30 interposing ring CT to be installed near Sepam (Sepam - CSH30 link less than 2 m (6.6 ft) long).
Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.

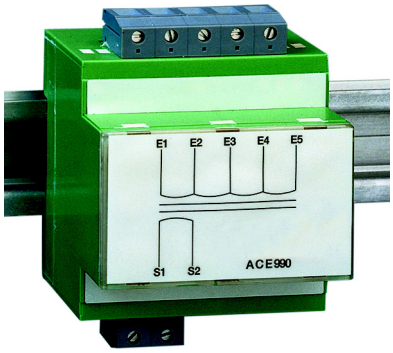
DE80126




6

# ACE990 Core balance CT interface

PE80318




*ACE990 core balance CT interface.*

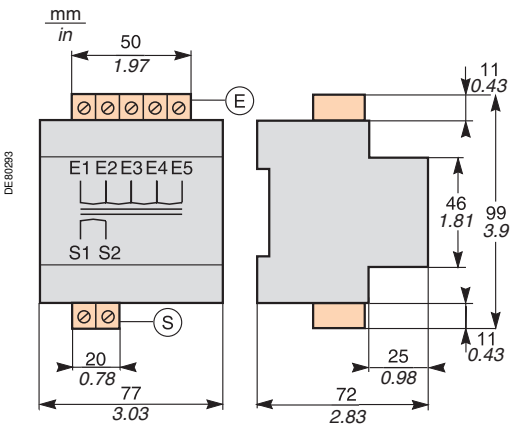
## Function

The ACE990 is used to adapt measurements between an MV core balance CT with a ratio of 1/n (50 ⩽ n ⩽ 1500), and the Sepam residual current input.

## Characteristics

| | |
|---|---|
| Weight | 0.64 kg (1.41 lb) |
| Assembly | Mounted on symmetrical DIN rail |
| Amplitude accuracy | ±1% |
| Phase accuracy | < 2° |
| Maximum permissible current | 20 kA - 1 s<br>(on the primary winding of an MV core balance CT with a ratio of 1/50 that does not saturate) |
| Operating temperature | -5°C to +55°C (+23°F to +131°F) |
| Storage temperature | -25°C to +70°C (-13°F to +158°F) |

DE80293

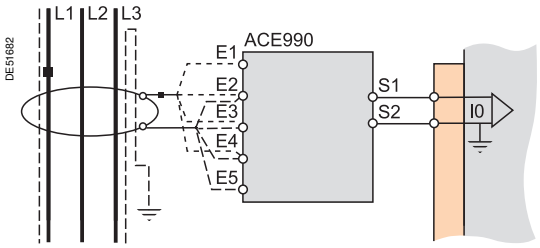



## Description and dimensions

(E) ACE990 input terminal block, for connection of the core balance CT.

(S) ACE990 output terminal block, for connection of the Sepam residual current.

6




## Connection

**Connection of core balance CT**

Only one core balance CT can be connected to the ACE990 interface.
The secondary circuit of the MV core balance CT is connected to 2 of the 5 ACE990 interface input terminals. To define the 2 input terminals, it is necessary to know the following:

- Core balance CT ratio (1/n)
- Core balance CT power
- Close approximation of rated current In0

(In0 is a general setting in Sepam and defines the earth fault protection setting range between 0.1 In0 and 15 In0).

The table below can be used to determine:

- The 2 ACE990 input terminals to be connected to the MV core balance CT secondary
- The type of residual current sensor to set
- The exact value of the rated residual current In0 setting, given by the following formula: **In0 = k x number of core balance CT turns**

with k the factor defined in the table below.

The core balance CT must be connected to the interface in the right direction for correct operation: the MV core balance CT secondary output terminal S1 must be connected to the terminal with the lowest index (Ex).

| K value | ACE990 input terminals to be connected | Residual current sensor setting | Min. MV core balance CT power |
|---|---|---|---|
| 0.00578 | E1 - E5 | ACE990 - range 1 | 0.1 VA |
| 0.00676 | E2 - E5 | ACE990 - range 1 | 0.1 VA |
| 0.00885 | E1 - E4 | ACE990 - range 1 | 0.1 VA |
| 0.00909 | E3 - E5 | ACE990 - range 1 | 0.1 VA |
| **0.01136** | **E2 - E4** | **ACE990 - range 1** | **0.1 VA** |
| 0.01587 | E1 - E3 | ACE990 - range 1 | 0.1 VA |
| 0.01667 | E4 - E5 | ACE990 - range 1 | 0.1 VA |
| 0.02000 | E3 - E4 | ACE990 - range 1 | 0.1 VA |
| 0.02632 | E2 - E3 | ACE990 - range 1 | 0.1 VA |
| 0.04000 | E1 - E2 | ACE990 - range 1 | 0.2 VA |
| 0.05780 | E1 - E5 | ACE990 - range 2 | 2.5 VA |
| 0.06757 | E2 - E5 | ACE990 - range 2 | 2.5 VA |
| 0.08850 | E1 - E4 | ACE990 - range 2 | 3.0 VA |
| 0.09091 | E3 - E5 | ACE990 - range 2 | 3.0 VA |
| 0.11364 | E2 - E4 | ACE990 - range 2 | 3.0 VA |
| 0.15873 | E1 - E3 | ACE990 - range 2 | 4.5 VA |
| 0.16667 | E4 - E5 | ACE990 - range 2 | 4.5 VA |
| 0.20000 | E3 - E4 | ACE990 - range 2 | 5.5 VA |
| 0.26316 | E2 - E3 | ACE990 - range 2 | 7.5 VA |

***Example:***
*Given a core balance CT with a ratio of 1/400 2 VA, used within a measurement range of 0.5 A to 60 A.*
*How should it be connected to Sepam via the ACE990?*

1. *Choose a close approximation of the rated current In0, i.e. 5 A.*
2. *Calculate the ratio: approx. In0/number of turns = 5/400 = 0.0125.*
3. *Find the closest value of k in the table opposite to k = 0.01136.*
4. *Check the mininum power required for the core balance CT: 2 VA core balance CT > 0.1 VA V OK.*
5. *Connect the core balance CT secondary to ACE990 input terminals E2 and E4.*
6. *Set Sepam up with: In0 = 0.0136 x 400 = 4.5 A.*

*This value of In0 can be used to monitor current between 0.45 A and 67.5 A.*

*Wiring of MV core balance CT secondary circuit:*

- *MV core balance CT S1 output to ACE990 E2 input terminal*
- *MV core balance CT S2 output to ACE990 E4 input terminal.*

**Connection to Sepam series 20 and Sepam series 40**

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

**Connection to Sepam series 60**

To residual current I0 input, on connector (E), terminals 15 and 14 (shielding).

**Connection to Sepam series 80**

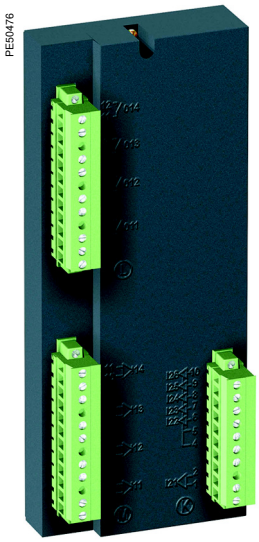
- To residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

**Recommended cables**

- Cable between core balance CT and ACE990: less than 50 m (160 ft) long
- Sheathed cable, shielded by tinned copper braid between the ACE990 and Sepam, maximum length 2 m (6.6 ft)
- Cable cross-section between 0.93 mm² (AWG 18) and 2.5 mm² (AWG 12)
- Resistance per unit length less than 100 mΩ/m (30.5 mΩ/ft)
- Minimum dielectric strength: 100 Vrms.

Connect the connection cable shielding in the shortest manner possible (2 cm or 5.08 in maximum) to the shielding terminal on the Sepam connector.
Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.

# MES114 modules




*10 input/4 output MES114 module.*

## Function

The 4 outputs included on the Sepam series 20 and 40 base unit can be extended by adding an optional MES114 module with 10 inputs and 4 outputs, available in 3 versions:

- MES114: 10 DC inputs, voltage from 24 V DC to 250 V DC
- MES114E: 10 inputs, voltage 110-125 V AC or V DC
- MES114F: 10 inputs, voltage 220-250 V AC or V DC.

## Characteristics

### MES114 module

| | |
|---|---|
| Weight | 0.28 kg (0.617 lb) |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |

| Logic inputs | | MES114 | MES114E | | MES114F | |
|---|---|---|---|---|---|---|
| Voltage | | 24 to 250 V DC | 110 to 125 V DC | 110 V AC | 220 to 250 V DC | 220 to 240 V AC |
| Range | | 19.2 to 275 V DC | 88 to 150 V DC | 88 to 132 V AC | 176 to 275 V DC | 176 to 264 V AC |
| Frequency | | - | - | 47 to 63 Hz | - | 47 to 63 Hz |
| Typical consumption | | 3 mA | 3 mA | 3 mA | 3 mA | 3 mA |
| Typical switching threshold | | 14 V DC | 82 V DC | 58 V AC | 154 V DC | 120 V AC |
| Input limit voltage | At state 1 | ⩾ 19 V DC | ⩾ 88 V DC | ⩾ 88 V AC | ⩾ 176 V DC | ⩾ 176 V AC |
| | At state 0 | ⩽ 6 V DC | ⩽ 75 V DC | ⩽ 22 V AC | ⩽ 137 V DC | ⩽ 48 V AC |
| Isolation of inputs from other isolated groups | | Enhanced | Enhanced | Enhanced | Enhanced | Enhanced |

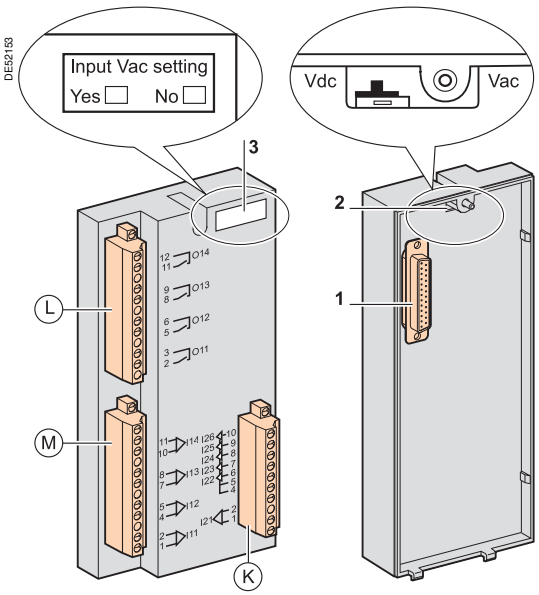
### O11 control relay output

| | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | DC | 24/48 V DC | 127 V DC | 220 V DC | 250 V DC | - |
| | AC (47.5 to 63 Hz) | - | - | - | - | 100 to 240 V AC |
| Continuous current | | 8 A | 8 A | 8 A | 8 A | 8 A |
| Breaking capacity | Resistive load | 8/4 A | 0.7 A | 0.3 A | 0.2 A | 8 A |
| | L/R load < 20 ms | 6/2 A | 0.5 A | 0.2 A | - | - |
| | L/R load < 40 ms | 4/1 A | 0.2 A | 0.1 A | - | - |
| | p.f. load > 0.3 | - | - | - | - | 5 A |
| Making capacity | | < 15 A for 200 ms | | | | |
| Isolation of outputs from other isolated groups | | Enhanced | | | | |

### Annunciation relay output O12 to O14

| | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | DC | 24/48 V DC | 127 V DC | 220 V DC | 250 V DC | - |
| | AC (47.5 to 63 Hz) | - | - | - | - | 100 to 240 V AC |
| Continuous current | | 2 A | 2 A | 2 A | 2 A | 2 A |
| Breaking capacity | Resistive load | 2/1 A | 0.6 A | 0.3 A | 0.2 A | - |
| | L/R load < 20 ms | 2/1 A | 0.5 A | 0.15 A | - | - |
| | p.f. load > 0.3 | - | - | - | - | 1 A |
| Making capacity | | < 15 A for 200 ms | | | | |
| Isolation of outputs in relation to other isolated groups | | Enhanced | | | | |

# MES114 modules




## Description

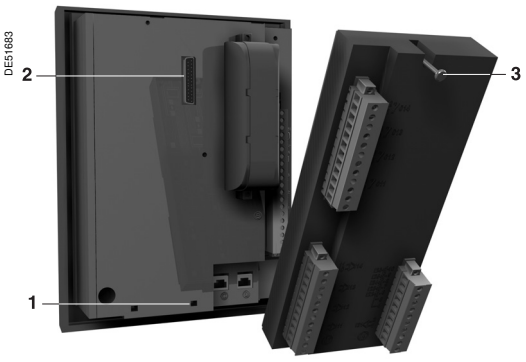
Ⓛ, Ⓜ and Ⓚ: 3 removable, lockable screw-type connectors
Ⓛ: connectors for 4 relay outputs:
- O11: 1 control relay output
- O12 to O14: 3 annunciation relay outputs

Ⓜ: connectors for 4 independent logic inputs I11 to I14
Ⓚ: connectors for 6 logic inputs:
- I21: 1 independent logic input
- I22 to I26: 5 common point logic inputs.

**1** 25-pin sub-D connector to connect the module to the base unit.
**2** Voltage selector switch for MES114E and MES114F module inputs, to be set to:
- V DC for 10 DC voltage inputs (default setting)
- V AC for 10 AC voltage inputs.

**3** Label to be filled in to indicate the chosen parameter setting for MES114E and MES114F input voltages.

The parameter setting status can be accessed in the "Sepam Diagnosis" screen of the SFT2841 software tool.
Parameter setting of the inputs for AC voltage (V AC setting) inhibits the "operating time measurement" function.




## Assembly

1. Insert the 2 pins on the MES module into the slots **1** on the base unit.
2. Flatten the module up against the base unit to plug it into the connector **2**.
3. Tighten the mounting screw **3**.

## Connection

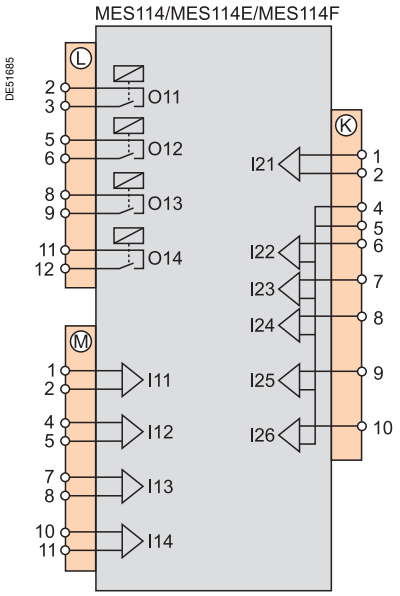
The inputs are potential-free and the DC power supply source is external.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Screw tight all terminals, even those not in use.

**Failure to follow these instructions will result in death or serious injury.**




Wiring of connectors Ⓛ, Ⓜ and Ⓚ:

- Wiring with no fittings:
  - 1 wire with maximum cross-section 0.2 to 2.5 $mm^2$ (AWG 24-12)
  - or 2 wires with maximum cross-section 0.2 to 1 $mm^2$ (AWG 24-18)
  - stripped length: 8 to 10 mm (0.315 to 0.39 in)
- Wiring with fittings:
  - terminal 5, recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 $mm^2$ (AWG 16)
    - DZ5CE025D for 1 wire 2.5 $mm^2$ (AWG 12)
    - AZ5DE010D for 2 wires 1 $mm^2$ (AWG 18)
  - tube length: 8.2 mm (0.32 in)
  - stripped length: 8 mm (0.31 in).

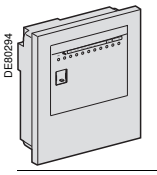
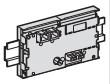
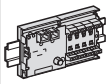
# Optional remote modules
## Connection

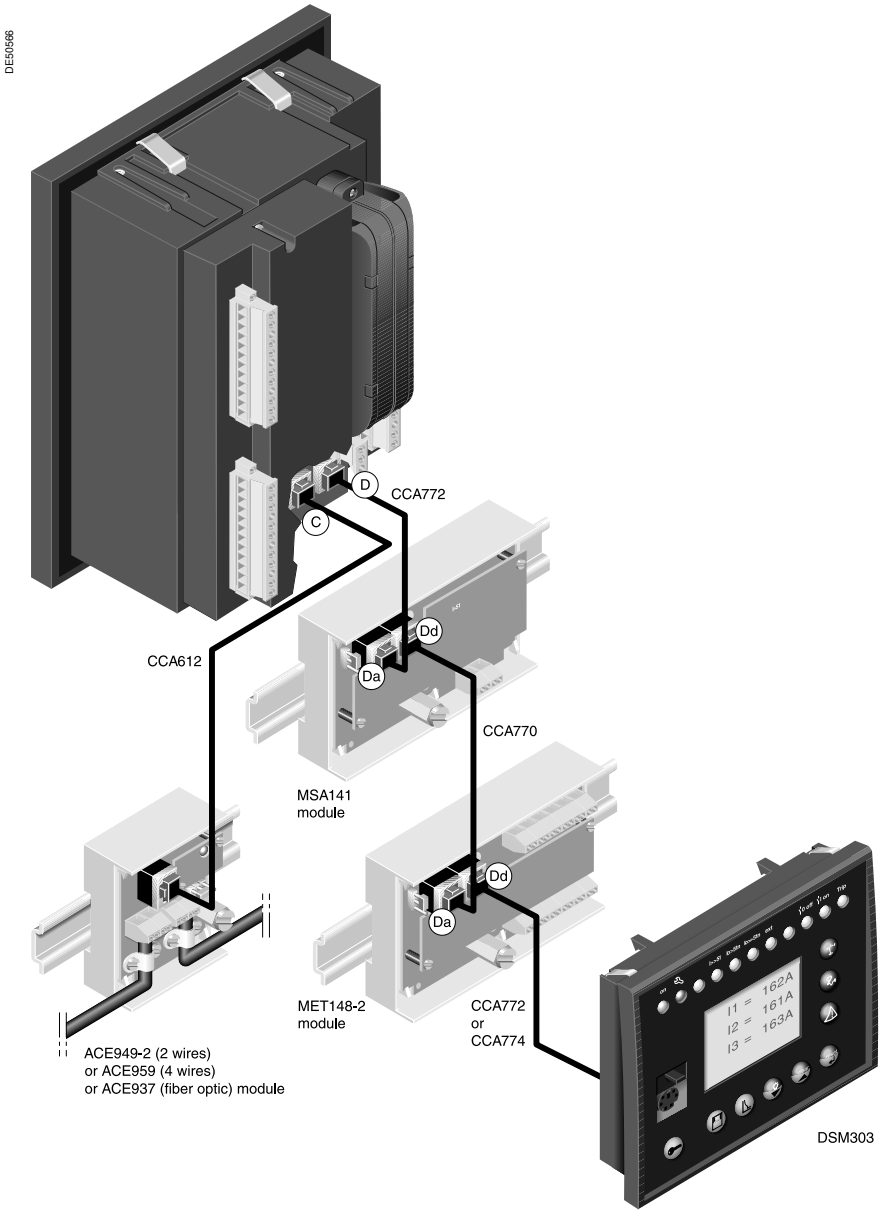
The optional MET148-2, MSA141 or DSM303 modules are connected to the base unit connector Ⓓ by a series of links using prefabricated cords which come in 3 different lengths with black fittings.
- CCA770 (L = 0.6 m or 2 ft)
- CCA772 (L = 2 m or 6.6 ft)
- CCA774 (L = 4 m or 13.1 ft).

The DSM303 module may only be connected at the end of the series.

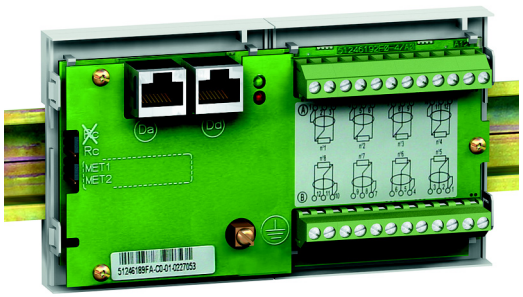
### Maximum configuration

A maximum of three modules may be connected to the base unit, in compliance with the module order and maximum connection lengths indicated in the table:

| Base | Cord | Module 1 | Cord | Module 2 | Cord | Module 3 |
|---|---|---|---|---|---|---|
|  | |  | |  | | |
| | CCA772 | MSA141 | CCA770 | MET148-2 | CCA774 | DSM303 |
| | CCA772 | MSA141 | CCA770 | MET148-2 | CCA772 | MET148-2 |
| | CCA772 | MET148-2 | CCA770 | MET148-2 | CCA774 | DSM303 |



# MET148-2
# Temperature sensor module



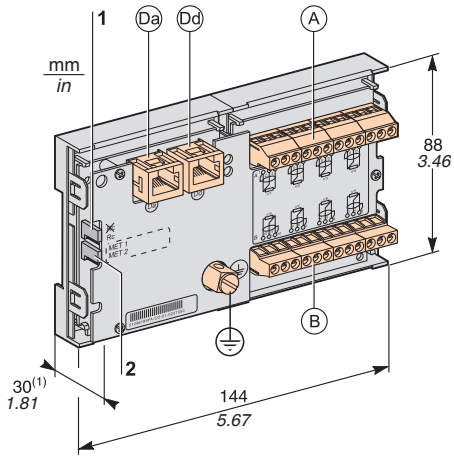

## Function

The MET148-2 module can be used to connect 8 temperature sensors (RTDs) of the same type:
- Pt100, Ni100 or Ni120 type RTDs, according to parameter setting
- 3-wire temperature sensors
- A single module for each Sepam series 20 base unit, to be connected by one of the CCA770 (0.6 or 2 ft), CCA772 (2 m or 6.6 ft) or CCA774 (4 m or 13.1 ft) cords
- 2 modules for each Sepam series 40, Sepam series 60 or Sepam series 80 base unit, to be connected by CCA770 (0.6 or 2 ft), CCA772 (2 m or 6.6 ft) or CCA774 (4 m or 13.1 ft) cords

The temperature measurement (e.g. in a transformer or motor winding) is utilized by the following protection functions:
- Thermal overload (to take ambient temperature into account)
- Temperature monitoring.

## Characteristics

| MET148-2 module | | |
|---|---|---|
| Weight | 0.2 kg (0.441 lb) | |
| Assembly | On symmetrical DIN rail | |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) | |
| Environmental characteristics | Same characteristics as Sepam base units | |
| **Temperature sensors** | **Pt100** | **Ni100/Ni120** |
| Isolation from earth | None | None |
| Current injected in RTD | 4 mA | 4 mA |




***(1)*** *70 mm (2.8 in) with CCA77x cord connected.*

## Description and dimensions

- (A) Terminal block for RTDs 1 to 4
- (B) Terminal block for RTDs 5 to 8
- (Da) RJ45 connector to connect the module to the base unit with a CCA77x cord
- (Dd) RJ45 connector to link up the next remote module with a CCA77x cord (according to application)
- (⏚) Grounding/earthing terminal

**1** Jumper for impedance matching with load resistor (Rc), to be set to:
- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

**2** Jumper used to select module number, to be set to:
- MET1: 1st MET148-2 module, to measure temperatures T1 to T8 (default position)
- MET2: 2nd MET148-2 module, to measure temperatures T9 to T16 (for Sepam series 40, Sepam series 60 and series 80 only).

# MET148-2
# Temperature sensor module

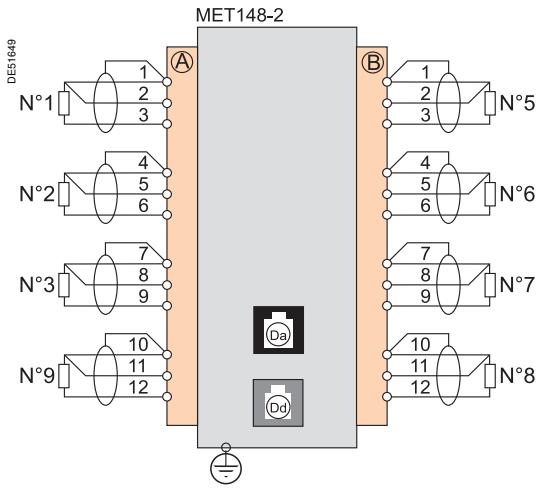
## Connection

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

**Failure to follow these instructions will result in death or serious injury.**




**Connection of the earthing terminal**

By tinned copper braid with cross-section ⩾ 6 mm² (AWG 10) or cable with cross-section ⩾ 2.5 mm² (AWG 12) and length ⩽ 200 mm (7.9 in), fitted with a 4 mm (0.16 in) ring lug.

Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).

**Connection of RTDs to screw-type connectors**

- 1 wire with cross-section 0.2 to 2.5 mm² (AWG 24-12)
- or 2 wires with cross-section 0.2 to 1 mm² (AWG 24-18)

Recommended cross-sections according to distance:

- Up to 100 m (330 ft) ⩾ 1 mm² (AWG 18)
- Up to 300 m (990 ft) ⩾ 1.5 mm² (AWG 16)
- Up to 1 km (0.62 mi) ⩾ 2.5 mm² (AWG 12)

Maximum distance between sensor and module: 1 km (0.62 mi)

**Wiring precautions**

- It is preferable to use shielded cables

The use of unshielded cables can cause measurement errors which vary in degree according to the level of surrounding electromagnetic disturbance

- Only connect the shielding at the MET148-2 end, in the shortest manner possible, to the corresponding terminals of connectors (A) and (B)
- Do not connect the shielding at the RTD end.

**Accuracy derating according to wiring**

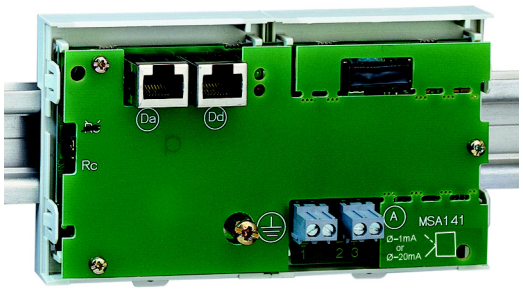
The error Δt is proportional to the length of the cable and inversely proportional to the cable cross-section:

$$\Delta t(°C) = 2 \times \frac{L(km)}{S(mm^2)}$$

- ±2.1°C/km for 0.93 mm² cross-section (AWG 18)
- ±1°C/km for 1.92 mm² cross-section (AWG 14).

# MSA141 Analog output module

PE80748




*MSA141 analog output module.*

## Function

The MSA141 module converts one of the Sepam measurements into an analog signal:

- Selection of the measurement to be converted by parameter setting
- 0-1 mA, 0-10 mA, 4-20 mA, 0-20 mA analog signal according to parameter setting
- Scaling of the analog signal by setting minimum and maximum values of the converted measurement.

Example: the setting used to have phase current 1 as a 0-10 mA analog output with a dynamic range of 0 to 300 A is:

- minimum value = 0
- maximum value = 3000

- A single module for each Sepam base unit, to be connected by one of the CCA770 (0.6m or 2 ft), CCA772 (2m or 6.6 ft) or CCA774 (4m or 13.1 ft) cords.

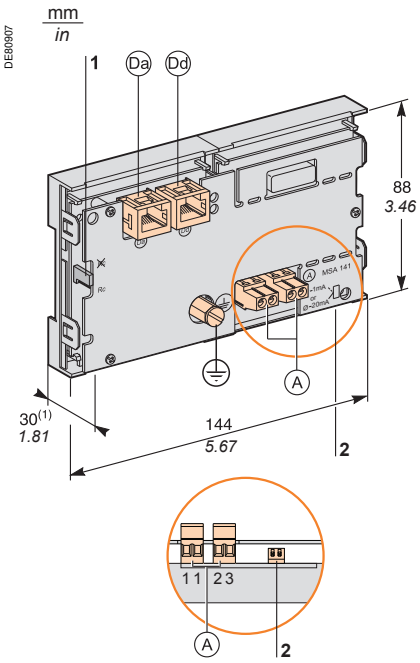
The analog output can also be remotely managed via the communication network.

## Characteristics

| **MSA141 module** | |
|---|---|
| Weight | 0.2 kg (0.441 lb) |
| Assembly | On symmetrical DIN rail |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |
| **Analog output** | |
| Current | 4 -20 mA, 0-20 mA, 0-10 mA, 0-1 mA |
| Scaling<br>(no data input checking) | Minimum value<br>Maximum value |
| Load impedance | < 600 Ω (including wiring) |
| Accuracy | 0.5% full scale or 0,01 mA |

| **Measurements available** | **Unit** | **Series 20** | **Series 40** | **Series 60/ Series 80** |
|---|---|---|---|---|
| Phase and residual currents | 0.1 A | ■ | ■ | ■ |
| Phase-to-neutral and phase-to-phase voltages | 1 V | ■ | ■ | ■ |
| Frequency | 0.01 Hz | ■ | ■ | ■ |
| Thermal capacity used | 1% | ■ | ■ | ■ |
| Temperatures | 1°C (1°F) | ■ | ■ | ■ |
| Active power | 0.1 kW | | ■ | ■ |
| Reactive power | 0.1 kvar | | ■ | ■ |
| Apparent power | 0.1 kVA | | ■ | ■ |
| Power factor | 0.01 | | | ■ |
| Remote setting via communication link | | ■ | ■ | ■ |

# MSA141 Analog output module




***(1)*** *70 mm (2.8 in) with CCA77x cord connected.*

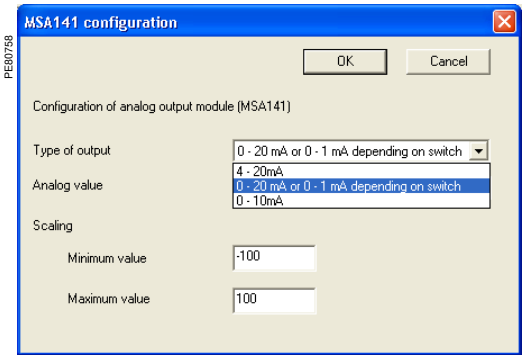
## Description and dimensions

Ⓐ Terminal block for analog output
Ⓓa RJ45 socket to connect the module to the base unit with a CCA77x cord
Ⓓd RJ45 socket to link up the next remote module with a CCA77x cord (according to application)
⏚ Earthing terminal

**1** Jumper for impedance matching with load resistor (Rc), to be set to:
- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

**2** Micro-switches to set the analog output type:

| Micro-switches | Position | Output type |
|---|---|---|
| 1 2 | low (default position) | 0-20 mA |
| | | 4-20 mA |
| | | 0-10 mA |
| 1 2 | high | 0-1 mA |



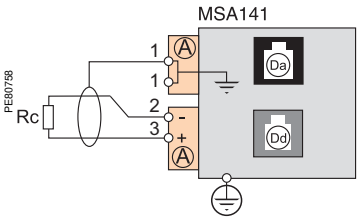

*Analog output module (MSA141) setting window.*

## Output Setting

The analog output type is configured in 2 steps:
1. Hardware setting: set the 2 micro-switches:
- on low position for a 0-20 mA, 4-20 mA or 0-10 mA output type
- on high position for a 0-1 mA output type.

2. Software configuration: select the desired output type in the SFT2841 setting software **Analog output module (MSA141) setting** window and validate by pressing the **OK** button.

***Note :*** *The 0-1 mA output works only if the* ***0-20 mA or 0-1 mA depending on switch*** *output type has been set in the SFT2841 setting software (step 2).*




## Connection

**Connection of the earthing terminal**
By tinned copper braid with cross-section ⩾ 6 mm² (AWG 10) or cable with cross-section ⩾ 2.5 mm² (AWG 12) and length ⩽ 200 mm (7.9 in), equipped with a 4 mm (0.16 in) ring lug.
Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).

**Connection of analog output to screw-type connector**
- 1 wire with cross-section 0.2 to 2.5 mm² (AWG 24-12)
- or 2 wires with cross-section 0.2 to 1 mm² (AWG 24-18).

**Wiring precautions**
- It is preferable to use shielded cables
- Use tinned copper braid to connect the shielding at least at the MSA141 end.

# DSM303
# Remote advanced UMI module

PE50127

*DSM303 remote advanced UMI module.*

## Function

When associated with a Sepam that does not have its own advanced user-machine interface, the DSM303 offers all the functions available on a Sepam integrated advanced UMI.
It can be installed on the front panel of the cubicle in the most suitable operating location:

- Reduced depth < 30 mm (1.2 in)
- A single module for each Sepam, to be connected by one of the CCA772 (2 m or 6.6 ft) or CCA774 (4 m or 13.1 ft) cords.

The module cannot be connected to Sepam units with integrated advanced UMIs.

## Characteristics

| DSM303 module | |
|---|---|
| Weight | 0.3 kg (0.661 lb) |
| Assembly | Flush-mounted |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |

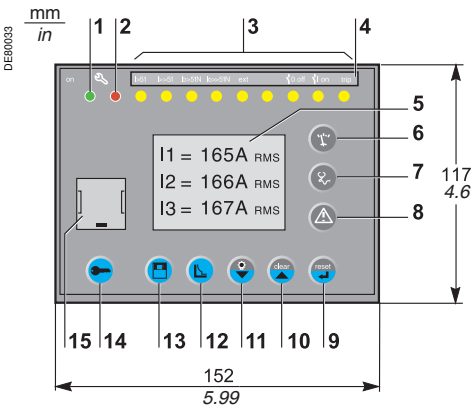
6

# DSM303
# Remote advanced UMI module

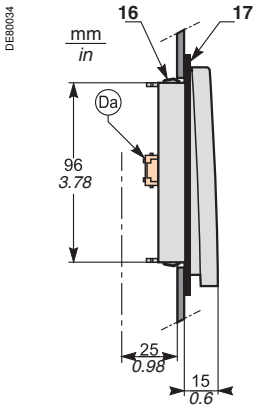
## Description and dimensions

The module is simply flush-mounted and secured by its clips. No additional screw-type fastening is required.

**Front view**




**Side view**




**1** Green LED: Sepam on
**2** Red LED:
- steadily on: module unavailable
- flashing: Sepam link unavailable

**3** 9 yellow LEDs
**4** Label identifying the LEDs
**5** Graphic LCD screen
**6** Display of measurements
**7** Display of switchgear, network and machine diagnosis data
**8** Display of alarm messages
**9** Sepam reset (or confirm data entry)
**10** Alarm acknowledgment and clearing (or move cursor up)
**11** LED test (or move cursor down)
**12** Access to protection settings
**13** Access to Sepam parameters
**14** Entry of 2 passwords
**15** PC connection port
**16** Mounting clip
**17** Gasket to ensure NEMA 12 tightness
(gasket supplied with the DSM303 module, to be installed if necessary)

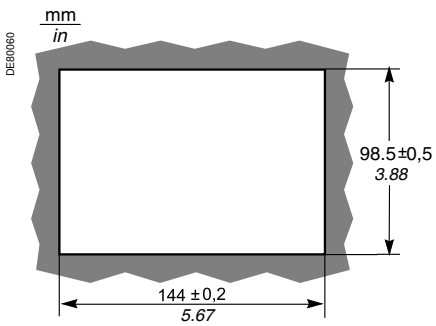
(Da) RJ45 lateral output connector to connect the module to the base unit with a CCA77x cord.

**⚠ CAUTION**

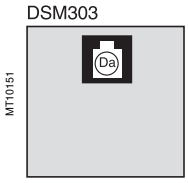
**HAZARD OF CUTS**
Trim the edges of the cut-out plates to remove any jagged edges.

**Failure to follow these instructions can result in injury.**

**Cut-out for flush-mounting (mounting plate thickness < 3 mm or 0.12 in)**




## Connection




(Da) RJ45 socket to connector the module to the base unit with a CCA77x cord.
The DSM303 module is always the last interlinked remote module and it systematically ensures impedance matching by load resistor (Rc).

# Communication accessory selection guide

There are 2 types of Sepam communication accessory:
■ Communication interfaces, which are essential for connecting Sepam to the communication network
■ Converters and other accessories, as options, which are used for complete implementation of the communication network.

## Communication-interface selection guide

| | | ACE949-2 | ACE959 | ACE937 | ACE969TP-2 | | ACE969FO-2 | | ACE850TP | ACE850FO |
|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Sepam** | | | | | | | | | | |
| Sepam series 20 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Sepam series 40/60/80 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Type of network** | | | | | | | | | | |
| | | S-LAN or E-LAN (1) | S-LAN or E-LAN (1) | S-LAN or E-LAN (1) | S-LAN | E-LAN | S-LAN | E-LAN | S-LAN and E-LAN | S-LAN and E-LAN |
| **Protocol** | | | | | | | | | | |
| Modbus RTU | | ■ | ■ | ■ | ■ (3) | ■ | ■ (3) | ■ | | |
| DNP3 | | | | | ■ (3) | | ■ (3) | | | |
| IEC 60870-5-103 | | | | | ■ (3) | | ■ (3) | | | |
| Modbus TCP/IP | | | | | | | | | ■ | ■ |
| IEC 61850 | | | | | | | | | ■ | ■ |
| **Physical interface** | | | | | | | | | | |
| RS 485 | 2-wire | ■ | | | ■ | ■ | | ■ | | |
| | 4-wire | | ■ | | | | | | | |
| Fiber optic ST | Star | | | ■ | | | ■ | | | |
| | Ring | | | | | | ■ (2) | | | |
| 10/100 base Tx | 2 ports | | | | | | | | ■ | |
| 100 base Fx | 2 ports | | | | | | | | | ■ |
| **Power supply** | | | | | | | | | | |
| DC | | Supplied by Sepam | Supplied by Sepam | Supplied by Sepam | 24 to 250 V | | 24 to 250 V | | 24 to 250 V | 24 to 250 V |
| AC | | | | | 110 to 240 V | | 110 to 240 V | | 110 to 240 V | 110 to 240 V |
| **See details on page** | | **page 243** | **page 244** | **page 245** | **page 246** | | **page 246** | | **page 252** | **page 252** |

***(1)*** *Only one connection possible, S-LAN or E-LAN.*
***(2)*** *Except with the Modbus RTU protocol.*
***(3)*** *Not supported simultaneously (1 protocol per application).*

## Converter selection guide

| | ACE909-2 | ACE919CA | ACE919CC | EGX100 | EGX300 | ECI850 |
|---|---|---|---|---|---|---|
| **To supervisor** | | | | | | |
| Physical interface | 1 RS 232 port | 1 port 2-wire RS 485 | 1 port 2-wire RS 485 | 1 Ethernet port 10/100 base T | 1 Ethernet port 10/100 base T | 1 Ethernet port 10/100 base T |
| Modbus RTU | ■ (1) | ■ (1) | ■ (1) | | | |
| IEC 60870-5-103 | ■ (1) | ■ (1) | ■ (1) | | | |
| DNP3 | ■ (1) | ■ (1) | ■ (1) | | | |
| Modbus TCP/IP | | | | ■ | ■ | |
| IEC 61850 | | | | | | ■ |
| **To Sepam** | | | | | | |
| Physical interface | 1 port 2-wire RS 485 | 1 port 2-wire RS 485 | 1 port 2-wire RS 485 | 1 port RS 485 2-wire or 4-wire | 1 port RS 485 2-wire or 4-wire | 1 port RS 485 2-wire or 4-wire |
| RS 485 distributed power supply | ■ | ■ | ■ | | | |
| Modbus RTU | ■ (1) | ■ (1) | ■ (1) | ■ | ■ | ■ |
| IEC 60870-5-103 | ■ (1) | ■ (1) | ■ (1) | | | |
| DNP3 | ■ (1) | ■ (1) | ■ (1) | | | |
| **Power supply** | | | | | | |
| DC | | | 24 to 48 V | 24 V | 24 V | 24 V |
| AC | 110 to 220 V | 110 to 220 V | | | | |
| **See details on page** | **page 259** | **page 260** | **page 260** | **See EGX100 manual** | **See EGX300 manual** | **page 262** |

***(1)*** *The supervisor protocol is the same as for Sepam.*

***Note:*** *All these interfaces support the E-LAN protocol.*

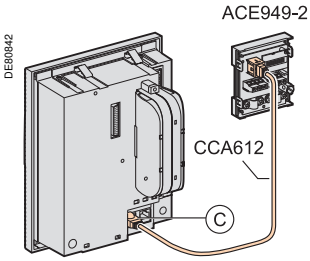
# Connection of communication interfaces
Connection cords

## CCA612 connection cord

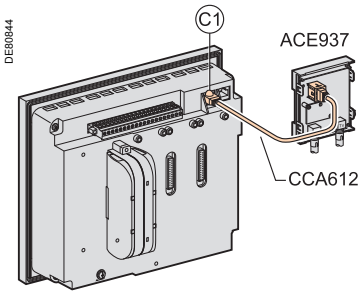
### Function
The CCA612 prefabricated cord is used to connect ACE949-2, ACE959, ACE937, ACE969TP-2 and ACE969FO-2 communication interfaces:
- To the white communication port (C) on a Sepam series 20 or series 40 base unit
- To the white communication port (C1) on a Sepam series 60 base unit.
- To the white communication ports (C1) or (C2) on a Sepam series 80 base unit.

### Characteristics
- Length = 3 m (9.8 ft)
- Fitted with 2 white RJ45 connectors.

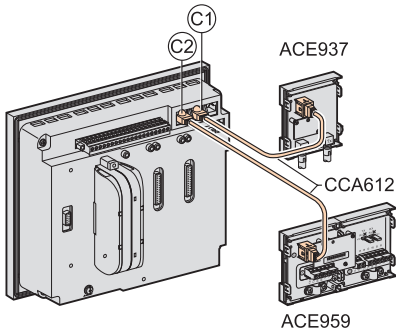
**Sepam series 20 and Sepam series 40**




**Sepam series 60**




**Sepam series 80**




## CCA614 connection cord

### Function
The CCA614 prefabricated cord is used to connect ACE850TP and ACE850FO communication interfaces:
- To the white communication port (C) on a Sepam series 40 base unit
- To the blue communication port (F) on a Sepam series 60 or Sepam series 80 base unit.

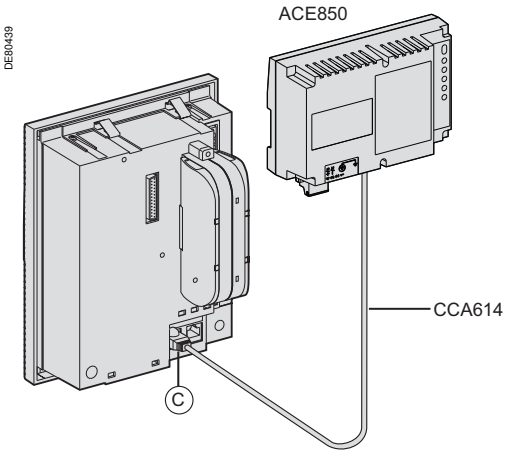
### Characteristics
- Length = 3 m (9.8 ft)
- Fitted with 2 blue RJ45 connectors
- Minimum curvature radius = 50 mm (1.97 in)

**CAUTION**

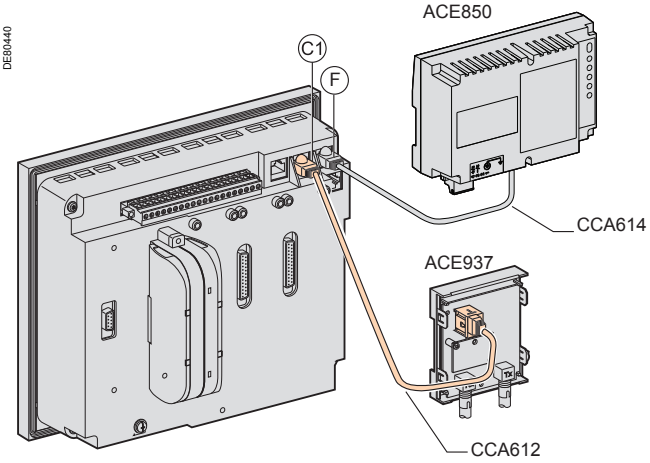
**HAZARD OF DEFECTIVE COMMUNICATION**
- Never use the (C2) and (F) communication ports on a Sepam series 80 simultaneously.
- The only communication ports on a Sepam series 80 unit that can be used simultaneously are ports (C1) and (C2) or ports (C1) and (F).

**Failure to follow these instructions can result in equipment damage.**

**Sepam series 40**




**Sepam series 60 and Sepam series 80**




6

# Connection of communication interfaces
Characteristics of communication networks

## RS 485 network for ACE949-2, ACE959 and ACE969TP-2 interfaces

| RS 485 network cable | 2-wire | 4-wire |
|---|---|---|
| RS 485 medium | 1 shielded twisted pair | 2 shielded twisted pairs |
| Distributed power supply | 1 shielded twisted pair | 1 shielded twisted pair |
| Shielding | Tinned copper braid, coverage > 65% | |
| Characteristic impedance | 120 Ω | |
| Gauge | AWG 24 | |
| Resistance per unit length | < 100 Ω/km (62.1 Ω/mi) | |
| Capacitance between conductors | < 60 pF/m (18.3 pF/ft) | |
| Capacitance between conductor and shielding | < 100 pF/m (30.5 pF/ft) | |
| Maximum length | 1300 m (4270 ft) | |

## Fiber-optic network for ACE937 and ACE969FO-2 interfaces

| Fiber-optic communication port | | | | |
|---|---|---|---|---|
| Fiber type | Graded-index multimode silica | | | |
| Wavelength | 820 nm (invisible infra-red) | | | |
| Type of connector | ST (BFOC bayonet fiber optic connector) | | | |
| **Fiber optic diameter (µm)** | **Numerical aperture (NA)** | **Maximum attenuation (dBm/km)** | **Minimum optical power available (dBm)** | **Maximum fiber length** |
| 50/125 | 0.2 | 2.7 | 5.6 | 700 m (2300 ft) |
| 62.5/125 | 0.275 | 3.2 | 9.4 | 1800 m (5900 ft) |
| 100/140 | 0.3 | 4 | 14.9 | 2800 m (9200 ft) |
| 200 (HCS) | 0.37 | 6 | 19.2 | 2600 m (8500 ft) |

## Fiber-optic Ethernet network for the ACE850FO communication interface

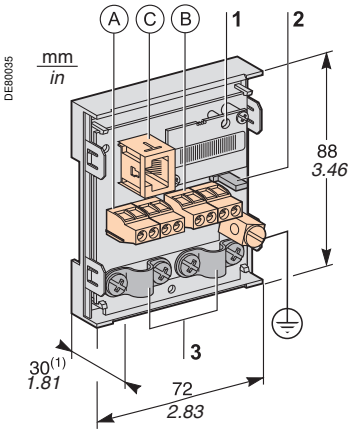
| Fiber-optic communication port | | | | | |
|---|---|---|---|---|---|
| Fiber type | Multimode | | | | |
| Wavelength | 1300 nm | | | | |
| Type of connector | SC | | | | |
| **Fiber optic diameter (µm)** | **TX minimum optical power (dBm)** | **TX maximum optical power (dBm)** | **RX sensitivity (dBm)** | **RX saturation (dBm)** | **Maximum distance** |
| 50/125 | -22.5 | -14 | -33.9 | -14 | 2 km (1.24 mi) |
| 62.5/125 | -19 | -14 | -33.9 | -14 | 2 km (1.24 mi) |

## Wired Ethernet network for the ACE850TP communication interface

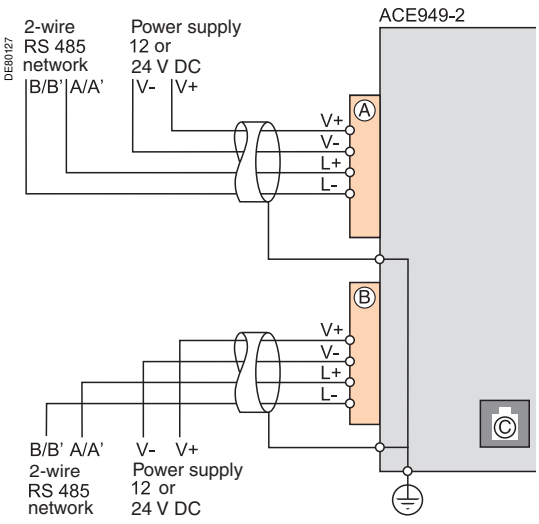
| Wired communication port | | | |
|---|---|---|---|
| **Connector type** | **Data** | **Medium** | **Maximum distance** |
| RJ45 | 10/100 Mbps | Cat 5 STP or FTP or SFTP | 100 m (328 ft) |

# ACE949-2
# 2-wire RS 485 network interface

*ACE949-2 2-wire RS 485 network connection interface.*




***(1)*** *70 mm (2.8 in) with CCA612 cord connected.*




## Function

The ACE949-2 interface performs 2 functions:
- Electrical interface between Sepam and a 2-wire RS 485 communication network
- Main network cable branching box for the connection of a Sepam with a CCA612 cord.

## Characteristics

| ACE949-2 module | |
|---|---|
| Weight | 0.1 kg (0.22 lb) |
| Assembly | On symmetrical DIN rail |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |
| **2-wire RS 485 electrical interface** | |
| Standard | EIA 2-wire RS 485 differential |
| Distributed power supply | External, 12 V DC or 24 V DC ±10% |
| Power consumption | 16 mA in receiving mode |
| | 40 mA maximum in sending mode |

**Maximum length of 2-wire RS 485 network with standard cable**

| Number of Sepam units | Maximum length with 12 V DC power supply | Maximum length with 24 V DC power supply |
|---|---|---|
| 5 | 320 m (1000 ft) | 1000 m (3300 ft) |
| 10 | 180 m (590 ft) | 750 m (2500 ft) |
| 20 | 160 m (520 ft) | 450 m (1500 ft) |
| 25 | 125 m (410 ft) | 375 m (1200 ft) |

## Description and dimensions

(A) and (B) Terminal blocks for network cable
(C) RJ45 socket to connect the interface to the base unit with a CCA612 cord
(t) Grounding/earthing terminal

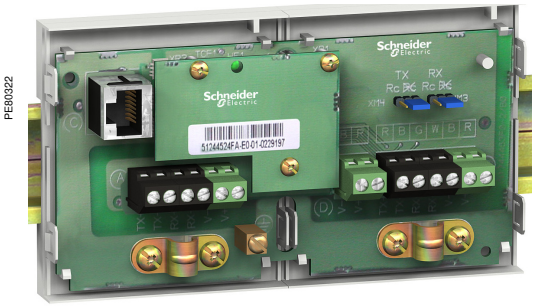
**1** Link activity LED, flashes when communication is active (sending or receiving in progress).
**2** Jumper for RS 485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the module is not at one end of the network (default position)
- Rc, if the module is at one end of the network.

**3** Network cable clamps
(inner diameter of clamp = 6 mm or 0.24 in).

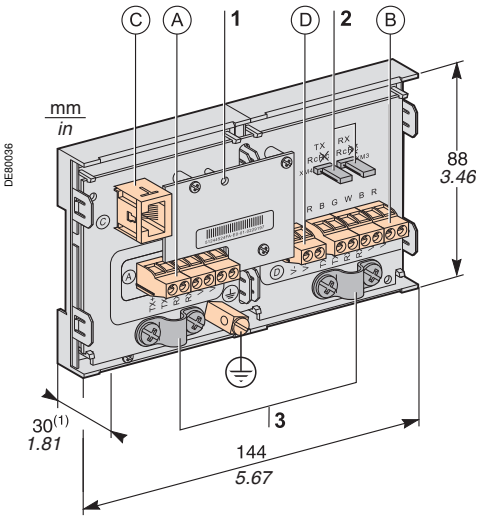
## Connection

- Connection of network cable to screw-type terminal blocks (A) and (B)
- Connection of the earthing terminal by tinned copper braid with cross-section ≥ 6 mm² (AWG 10) or cable with cross-section ≥ 2.5 mm² (AWG 12) and length ≤ 200 mm (7.9 in), fitted with a 4 mm (0.16 in) ring lug.
Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - the network cable must be stripped
  - the cable shielding braid must be around and in contact with the clamp
- The interface is to be connected to connector (C) on the base unit using a CCA612 cord (length = 3 m or 9.8 ft, white fittings)
- The interfaces are to be supplied with 12 V DC or 24 V DC.

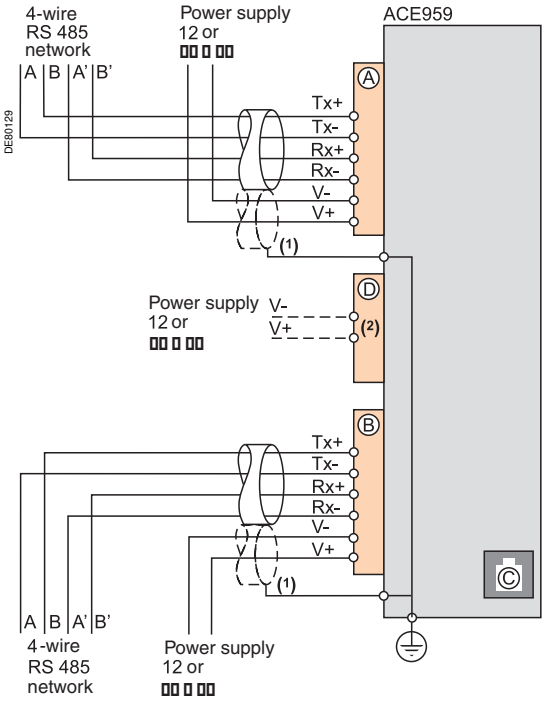
# ACE959
# 4-wire RS 485 network interface




*ACE959 4-wire RS 485 network connection interface.*




***(1)** 70 mm (2.8 in) with CCA612 cord connected.*




***(1)** Distributed power supply with separate wiring or included in the shielded cable (3 pairs).*
***(2)** Terminal block for connection of the distributed power supply module.*

## Function

The ACE959 interface performs 2 functions:
- Electrical interface between Sepam and a 4-wire RS 485 communication network
- Main network cable branching box for the connection of a Sepam with a CCA612 cord.

## Characteristics

| ACE959 module | |
|---|---|
| Weight | 0.2 kg (0.441 lb) |
| Assembly | On symmetrical DIN rail |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |

| 4-wire RS 485 electrical interface | |
|---|---|
| Standard | EIA 4-wire RS 485 differential |
| Distributed power supply | External, 12 V DC or 24 V DC ±10% |
| Power consumption | 16 mA in receiving mode |
| | 40 mA maximum in sending mode |

**Maximum length of 4-wire RS 485 network with standard cable**

| Number of Sepam units | Maximum length with 12 V DC power supply | Maximum length with 24 V DC power supply |
|---|---|---|
| 5 | 320 m (1000 ft) | 1000 m (3300 ft) |
| 10 | 180 m (590 ft) | 750 m (2500 ft) |
| 20 | 160 m (520 ft) | 450 m (1500 ft) |
| 25 | 125 m (410 ft) | 375 m (1200 ft) |

## Description and dimensions

(A) and (B) Terminal blocks for network cable
(C) RJ45 socket to connect the interface to the base unit with a CCA612 cord
(D) Terminal block for a separate auxiliary power supply (12 V DC or 24 V DC)
(t) Grounding/earthing terminal

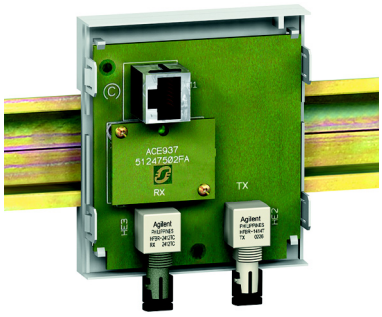
1. Link activity LED, flashes when communication is active (sending or receiving in progress).
2. Jumper for 4-wire RS 485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
   - ~~Rc~~, if the module is not at one end of the network (default position)
   - Rc, if the module is at one end of the network.
3. Network cable clamps
   (inner diameter of clamp = 6 mm or 0.24 in).

## Connection

- Connection of network cable to screw-type terminal blocks (A) and (B)
- Connection of the earthing terminal by tinned copper braid with cross-section ≥ 6 mm² (AWG 10) or cable with cross-section ≥ 2.5 mm² (AWG 12) and length ≤ 200 mm (7.9 in), fitted with a 4 mm (0.16 in) ring lug.
  Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - the network cable must be stripped
  - the cable shielding braid must be around and in contact with the clamp
- The interface is to be connected to connector (C) on the base unit using a CCA612 cord (length = 3 m or 9.8 ft, white fittings)
- The interfaces are to be supplied with 12 V DC or 24 V DC
- The ACE959 can be connected to a separate distributed power supply (not included in shielded cable). Terminal block (D) is used to connect the distributed power supply module.

# ACE937 fiber optic interface

PE50024




*ACE937 fiber optic connection interface.*

## Function

The ACE937 interface is used to connect Sepam to a fiber optic communication star system.
This remote module is connected to the Sepam base unit by a CCA612 cord.

## Characteristics

| ACE937 module | |
|---|---|
| Weight | 0.1 kg (0.22 lb) |
| Assembly | On symmetrical DIN rail |
| Power supply | Supplied by Sepam |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) |
| Environmental characteristics | Same characteristics as Sepam base units |

| Fiber optic interface | | | | |
|---|---|---|---|---|
| Fiber type | | Graded-index multimode silica | | |
| Wavelength | | 820 nm (invisible infra-red) | | |
| Type of connector | | ST (BFOC bayonet fiber optic connector) | | |
| **Fiber optic diameter (µm)** | **Numerical aperture (NA)** | **Maximum attenuation (dBm/km)** | **Minimum optical power available (dBm)** | **Maximum fiber length** |
| 50/125 | 0.2 | 2.7 | 5.6 | 700 m (2300 ft) |
| 62.5/125 | 0.275 | 3.2 | 9.4 | 1800 m (5900 ft) |
| 100/140 | 0.3 | 4 | 14.9 | 2800 m (9200 ft) |
| 200 (HCS) | 0.37 | 6 | 19.2 | 2600 m (8500 ft) |

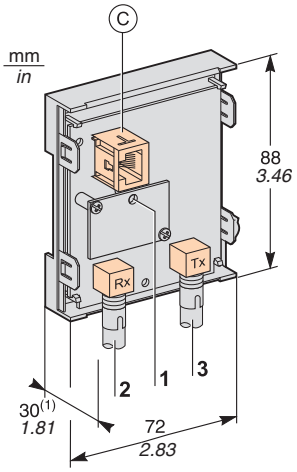
Maximum length calculated with:
- Minimum optical power available
- Maximum fiber attenuation
- Losses in 2 ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard).

**Example for a 62.5/125 µm fiber**
Lmax = (9.4 - 3 - 0.6)/3.2 = 1.8 km (1.12 mi)

**⚠ CAUTION**

**HAZARD OF BLINDING**
Never look directly into the end of the fiber optic.
**Failure to follow these instructions can result in serious injury.**

DE80037



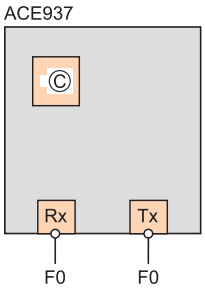

***(1)*** *70 mm (2.8 in) with CCA612 cord connected.*

## Description and dimensions

Ⓒ RJ45 socket to connect the interface to the base unit with a CCA612 cord.

**1** Link activity LED, flashes when communication is active (sending or receiving in progress).
**2** Rx, female ST type connector (Sepam receiving).
**3** Tx, female ST type connector (Sepam sending).

DE51666



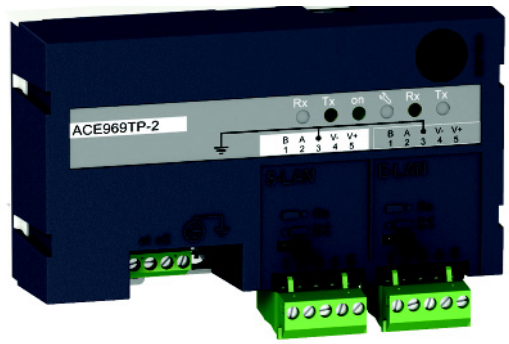

## Connection

- The sending and receiving fiber optic fibers must be equipped with male ST type connectors
- Fiber optics screw-locked to Rx and Tx connectors.

The interface is to be connected to connector Ⓒ on the base unit using a CCA612 cord (length = 3 m or 9.8 ft, white fittings).

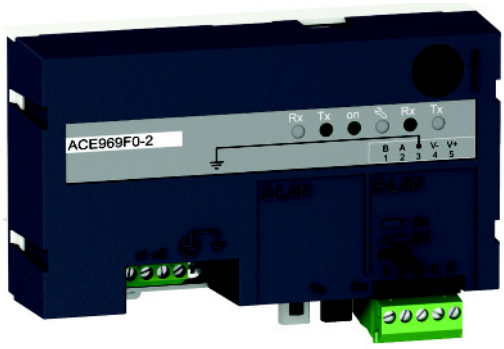
# ACE969TP-2 and ACE969FO-2 Multi-protocol interfaces

PB103454




*ACE969TP-2 communication interface.*

PB103453




*ACE969FO-2 communication interface.*

## Function

The ACE969 multi-protocol communication interfaces are for Sepam series 20, Sepam series 40, Sepam series 60 and Sepam series 80.
They have two communication ports to connect a Sepam to two independent communication networks:

- The S-LAN (Supervisory Local Area Network) port is used to connect Sepam to a communication network dedicated to supervision, using one of the three following protocols:
  - IEC 60870-5-103
  - DNP3
  - Modbus RTU.

The communication protocol is selected at the time of Sepam parameter setting.

- The E-LAN (Engineering Local Area Network) port, reserved for Sepam remote parameter setting and operation using the SFT2841 software.

There are two versions of the ACE969 interfaces, which are identical except for the S-LAN port:

- ACE969TP-2 (Twisted Pair), for connection to an S-LAN network using a 2-wire RS 485 serial link
- ACE969FO-2 (Fiber Optic), for connection to an S-LAN network using a fiber-optic connection (star or ring).

The E-LAN port is always a 2-wire RS 485 type port.

## Compatible Sepam

The ACE969TP-2 and ACE969FO-2 multi-protocol interfaces are compatible with the following Sepam:

- Sepam series 20 version ≥ V0526
- Sepam series 40 version ≥ V3.00
- Sepam series 60 all versions
- Sepam series 80 base version and application version ≥ V3.00.

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# ACE969TP-2 and ACE969FO-2 Multi-protocol interfaces

## Characteristics

| ACE969TP-2 and ACE969FO-2 module | | |
|---|---|---|
| **Technical characteristics** | | |
| Weight | 0.285 kg (0.628 lb) | |
| Assembly | On symmetrical DIN rail | |
| Operating temperature | -25°C to +70°C (-13°F to +158°F) | |
| Environmental characteristics | Same characteristics as Sepam base units | |
| **Power supply** | | |
| Voltage | 24 to 250 V DC | 110 to 240 V AC |
| Range | -20%/+10% | -20%/+10% |
| Maximum consumption | 2 W | 3 VA |
| Inrush current | < 10 A 100 µs | |
| Acceptable ripple content | 12% | |
| Acceptable momentary outages | 20 ms | |

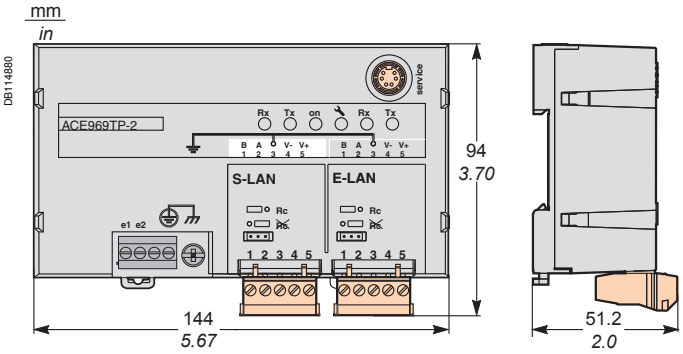
| 2-wire RS 485 communication ports | |
|---|---|
| **Electrical interface** | |
| Standard | EIA 2-wire RS 485 differential |
| Distributed power supply | ACE969-2 not required (built-in) |

| Fiber optic communication port | | | | |
|---|---|---|---|---|
| **Fiber optic interface** | | | | |
| Fiber type | Graded-index multimode silica | | | |
| Wavelength | 820 nm (invisible infra-red) | | | |
| Type of connector | ST (BFOC bayonet fiber optic connector) | | | |
| **Maximum length of fiber optic network** | | | | |
| **Fiber diameter (µm)** | **Numerical aperture (NA)** | **Attenuation (dBm/km)** | **Minimum optical power available (dBm)** | **Maximum fiber length** |
| 50/125 | 0.2 | 2.7 | 5.6 | 700 m (2300 ft) |
| 62.5/125 | 0.275 | 3.2 | 9.4 | 1800 m (5900 ft) |
| 100/140 | 0.3 | 4 | 14.9 | 2800 m (9200 ft) |
| 200 (HCS) | 0.37 | 6 | 19.2 | 2600 m (8500 ft) |

Maximum length calculated with:
- Minimum optical power available
- Maximum fiber attenuation
- Losses in 2 ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard).

**Example for a 62.5/125 µm fiber**
Lmax = (9.4 - 3 - 0.6)/3.2 = 1.8 km (1.12 mi).

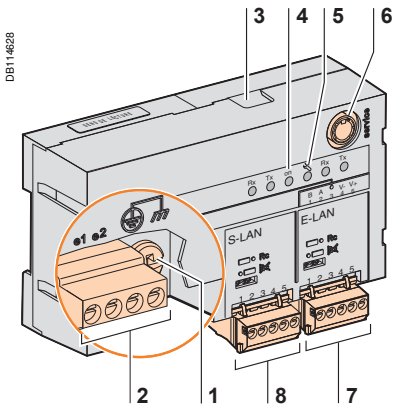
## Dimensions



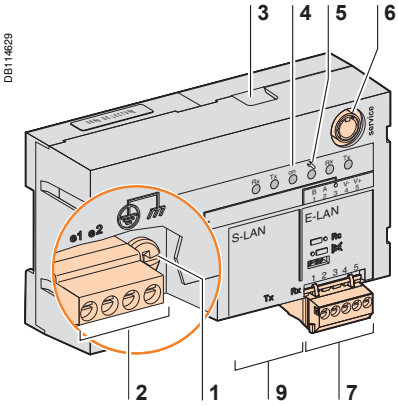
# ACE969TP-2 and ACE969FO-2 Multi-protocol interfaces
Description

## ACE969-2 communication interfaces

**ACE969TP-2**




**ACE969FO-2**

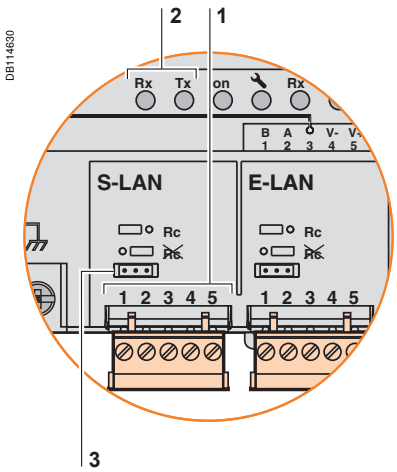



**1** Grounding/earthing terminal using supplied braid
**2** Power-supply terminal block
**3** RJ45 socket to connect the interface to the base unit with a CCA612 cord
**4** Green LED: ACE969-2 energized
**5** Red LED: ACE969-2 interface status
- LED off = ACE969-2 set up and communication operational
- LED flashing = ACE969-2 not set up or setup incorrect
- LED remains on = ACE969-2 has faulted

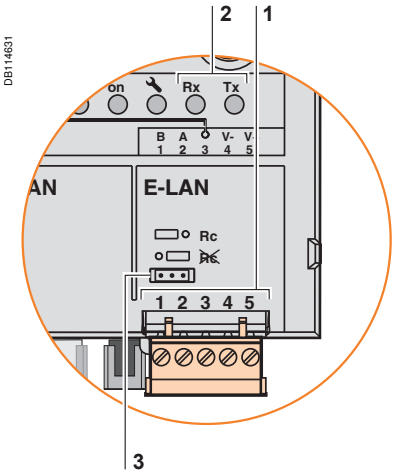
**6** Service connector: reserved for software upgrades
**7** E-LAN 2-wire RS 485 communication port (ACE969TP-2 and ACE969FO-2)
**8** S-LAN 2-wire RS 485 communication port (ACE969TP-2)
**9** S-LAN fiber-optic communication port (ACE969FO-2).

## 2-wire RS 485 communication ports

**S-LAN port (ACE969TP-2)**




**E-LAN port (ACE969TP-2 or ACE969FO-2)**



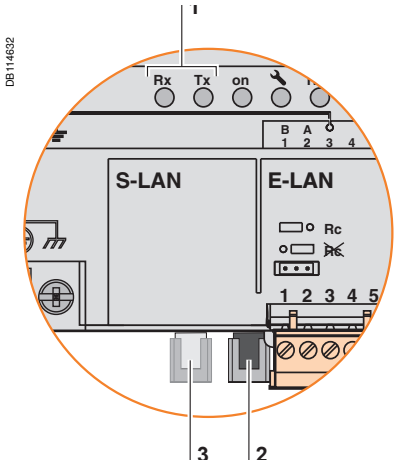

**1** Draw-out terminal block, with two rows of connections to the RS 485 2-wire network:
- 2 black terminals: connection of RS 485 twisted-pair (2 wires)
- 2 green terminals: connection of twisted pair for distributed power supply

**2** Indication LEDs:
- flashing Tx LED: Sepam sending
- flashing Rx LED: Sepam receiving

**3** Jumper for RS 485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the interface is not at the line end (default position)
- Rc, if the interface is at the line end.

## Fiber optic communication port

**S-LAN port (ACE969FO-2)**




**1** Indication LEDs:
- flashing Tx LED: Sepam sending
- flashing Rx LED: Sepam receiving

**2** Rx, female ST-type connector (Sepam receiving)
**3** Tx, female ST-type connector (Sepam sending).

# ACE969TP-2 and ACE969FO-2 Multi-protocol interfaces
Connection

## Power supply and Sepam

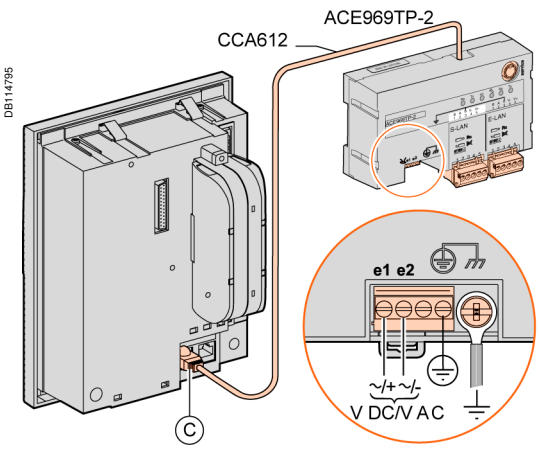
■ The ACE969-2 interface connects to connector C on the Sepam base unit using a CCA612 cord (length = 3 m or 9.84 ft, white RJ45 fittings)
■ The ACE969-2 interface must be supplied with 24 to 250 V DC or 110 to 240 V AC.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

■ Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
■ NEVER work alone.
■ Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
■ Always use a properly rated voltage sensing device to confirm that all power is off.
■ Start by connecting the device to the protective earth and to the functional earth.
■ Screw tight all terminals, even those not in use.

**Failure to follow these instructions will result in death or serious injury.**




| Terminals | Type | Wiring |
|---|---|---|
| e1-e2 - supply | Screw terminals | ■ Wiring with no fittings:<br>□ 1 wire with maximum cross-section 0.2 to 2.5 mm²(≥ AWG 24-12)<br>or 2 wires with maximum cross-section 0.2 to 1 mm²(≥ AWG 24-18)<br>□ stripped length: 8 to 10 mm (0.31 to 0.39 in)<br>■ Wiring with fittings:<br>□ recommended wiring with Schneider Electric fitting:<br>- DZ5CE015D for 1 wire 1.5 mm² (AWG 16)<br>- DZ5CE025D for 1 wire 2.5 mm² (AWG 12)<br>- AZ5DE010D for 2 wires 1 mm² (AWG 18)<br>□ tube length: 8.2 mm (0.32 in)<br>□ stripped length: 8 mm (0.31 in). |
| DE51962 Protective earth | Screw terminal | 1 green/yellow wire, max. length 3 m (9.8 ft) and max. cross-section 2.5 mm² (AWG 12) |
| DE51845 Functional earth | 4 mm (0.16 in) ring lug | Earthing braid, supplied for connection to cubicle grounding |

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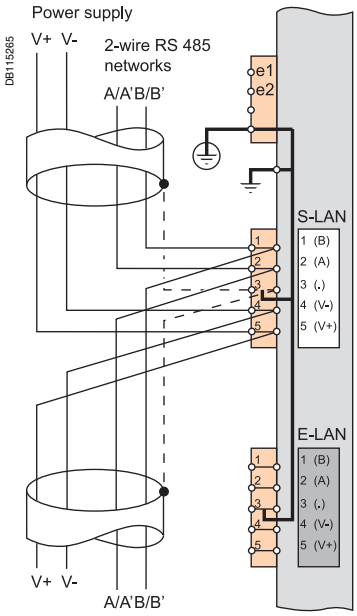
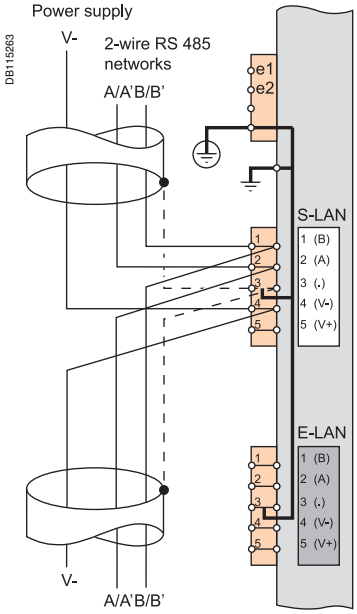



*If ACE969TP and ACE969TP-2 are used together, the external power supply is required.*

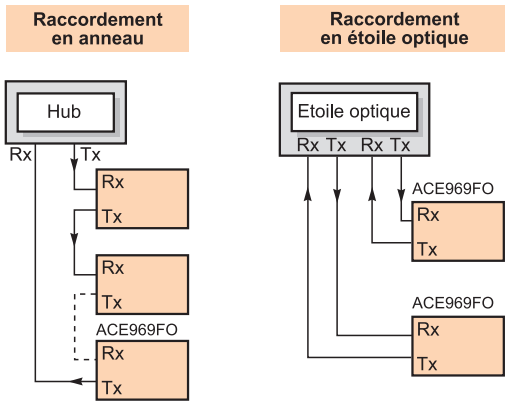



## 2-wire RS 485 communication ports (S-LAN or E-LAN)

- Connection of the RS 485 twisted pair (S-LAN or E-LAN) to terminals A and B
- In case of ACE 969TP wired with ACE969TP-2:
  - connection of twisted pair for distributed power supply to terminals 5(V+) et 4(V-)
- In case of ACE969TP-2 only:
  - connection only on the terminal 4(V-) ( ground continuity)
  - no need of external power supply
- The cable shields must be connected to the terminals marked 3(.) on the connection terminal blocks.
- Terminal marked 3(.) are linked by an internal connection to the earthing terminals of the ACETP-2 interface (protective an functional earthing): le the shielding of the RS 485 cables is earthed as well.
- On the ACE960TP-2 interface, the cable clamps for the S-LAN and E-LAN RS 485 networks are earthed by the terminal 3.

# ACE969TP-2 and ACE969FO-2 Multi-protocol interfaces
Connection

DE52165




## Fiber optic communication port (S-LAN)

**⚠ CAUTION**

**HAZARD OF BLINDING**
Never look directly into the fiber optic.
**Failure to follow these instructions can result in injury.**

The fiber optic connection can be made:
- point-to-point to an optic star system
- in a ring system (active echo).

The sending and receiving fiber optic fibers must be equipped with male ST type connectors.
The fiber optics are screw-locked to Rx and Tx connectors.

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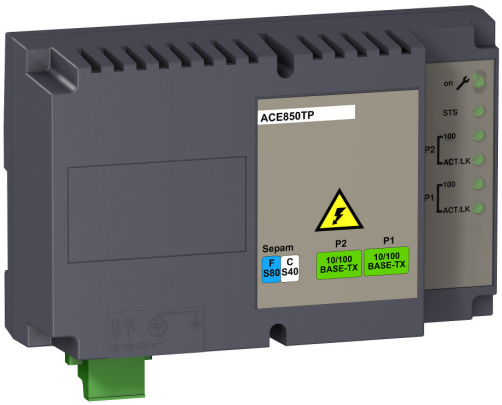
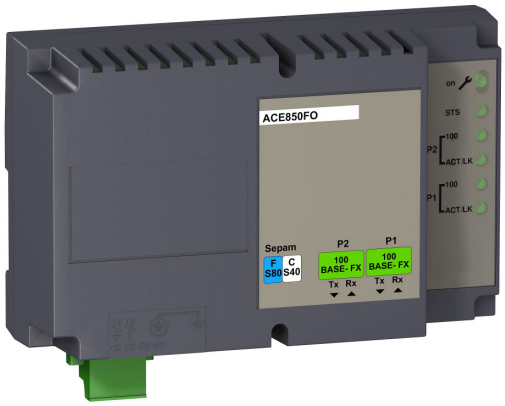
# ACE850TP and ACE850FO Multi-protocol interfaces

PB105301




*ACE850TP communication interface.*

PB105300




*ACE850FO communication interface.*

## Function

The ACE850 multi-protocol communication interfaces are for Sepam series 40, Sepam series 60 and Sepam series 80.
ACE850 interfaces have two Ethernet communication ports to connect a Sepam to a single Ethernet network depending on the topology (star or ring):
- For a star topology, only one communication port is used.
- For a ring topology, both Ethernet communication ports are used to provide redundancy. This redundancy conforms to the RSTP 802.1d 2004 standard.

Either port can be used for connection:
- To the S-LAN (Supervisory Local Area Network) port to connect Sepam to an Ethernet communication network dedicated to supervision, using one of the two following protocols:
  - IEC 61850
  - Modbus TCP/IP TR A15
- To the E-LAN (Engineering Local Area Network) port, reserved for Sepam remote parameter setting and operation using the SFT2841 software

There are two versions of the ACE850 interfaces, which are identical except for the type of port featured:
- ACE850TP (Twisted Pair), for connection to an Ethernet network (S-LAN or E-LAN) using a copper RJ45 10/100 Base TX Ethernet link
- ACE850FO (Fiber Optic), for connection to an Ethernet network (S-LAN or E-LAN) using a 100Base FX fiber-optic connection (star or ring)

## Compatible Sepam

The ACE850TP and ACE850FO multi-protocol communication interfaces are compatible with:
- Sepam series 40 version ⩾ V7.00
- Sepam series 60 all versions
- Sepam series 80 base version and application version ⩾ V6.00

The ACE850 multi-protocol communication interfaces will only work if TCP/IP firmware option (ref. 59754) has been ordered with Sepam series 40, Sepam series 60 or Sepam series 80.

# ACE850TP and ACE850FO Multi-protocol interfaces

## Characteristics

### ACE850TP and ACE850FO module

**Technical characteristics**

| | | | |
|---|---|---|---|
| Weight | | 0.4 kg (0.88 lb) | |
| Assembly | | On symmetrical DIN rail | |
| Operating temperature | | -25°C to +70°C (-13°F to +158°F) | |
| Environmental characteristics | | Same characteristics as Sepam base units | |
| **Power supply** | | | |
| Voltage | | 24 to 250 V DC | 110 to 240 V AC |
| Range | | -20%/+10% | -20%/+10% |
| Maximum consumption | ACE850TP | 3.5 W in DC | 1.5 VA in AC |
| | ACE850FO | 6.5 W in DC | 2.5 VA in AC |
| Inrush current | | < 10 A 10 ms in DC | < 15 A 10 ms in AC |
| Acceptable ripple content | | 12% | |
| Acceptable momentary outages | | 100 ms | |

### Wired Ethernet communication ports (ACE850TP)

| | |
|---|---|
| Number of ports | 2 x RJ45 ports |
| Type of port | 10/100 Base TX |
| Protocols | HTTP, FTP, SNMP, SNTP, ARP, SFT, IEC 61850, TCP/IP, RSTP 801.1d 2004 |
| Baud rate | 10 or 100 Mbps |
| Medium | Cat 5 STP or FTP or SFTP |
| Maximum distance | 100 m (328 ft) |

### Fiber-optic Ethernet communication ports (ACE850FO)

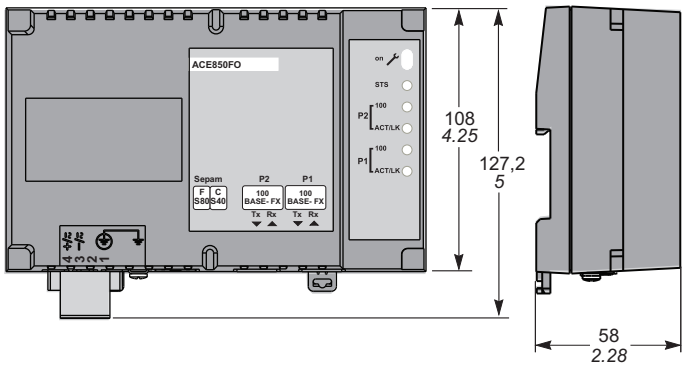
| | |
|---|---|
| Number of ports | 2 |
| Type of port | 100 Base FX |
| Protocols | HTTP, FTP, SNMP, SNTP, ARP, SFT, IEC 61850, TCP/IP, RSTP 801.1d 2004 |
| Baud rate | 100 Mbps |
| Fiber type | Multimode |
| Wavelength | 1300 nm |
| Type of connector | SC |

| Fiber optic diameter (µm) | Tx minimum optical power (dBm) | Tx maximum optical power (dBm) | RX sensitivity (dBm) | RX saturation (dBm) | Maximum distance |
|---|---|---|---|---|---|
| 50/125 | -22.5 | -14 | -33.9 | -14 | 2 km (1.24 mi) |
| 62.5/125 | -19 | -14 | -33.9 | -14 | 2 km (1.24 mi) |

## Dimensions

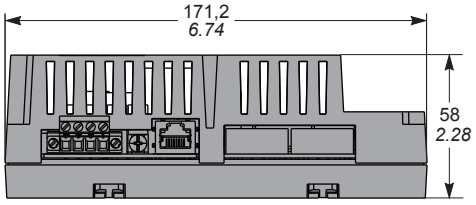
DE80441

mm
*in*



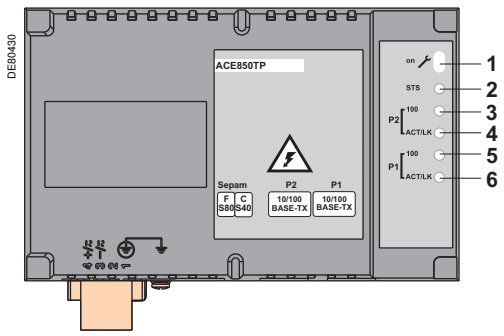

DE80403

mm
*in*

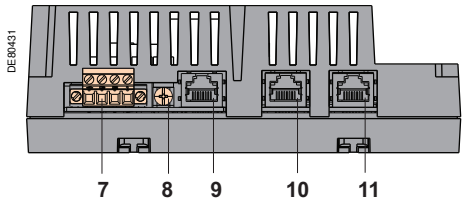


# ACE850TP and ACE850FO Multi-protocol interfaces
Description

## ACE850TP communication interface




*ACE850TP: Front view.*




*ACE850TP: View of underside.*

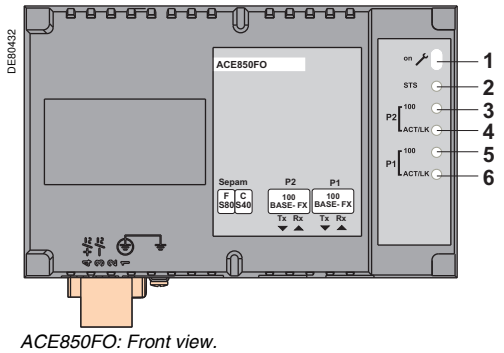
**1** ACE850 communication interface status LED
- ■ LED off = ACE850 de-energized
- ■ Green LED permanently on = ACE850 energized and operational
- ■ Red LED flashing = ACE850 not configured and/or not connected to the base unit
- ■ Red LED permanently on = ACE850 not operational (initialization in progress or failed)

**2** STS LED: communication status: green permanently on = OK
**3** Ethernet Port 2 100 green LED: off = 10 Mbps, permanently on = 100 Mbps
**4** Ethernet Port 2 activity LED: flashing on transmission/reception
**5** Ethernet Port 1 100 green LED: off = 10 Mbps, permanently on = 100 Mbps
**6** Ethernet Port 1 activity LED: flashing on transmission/reception

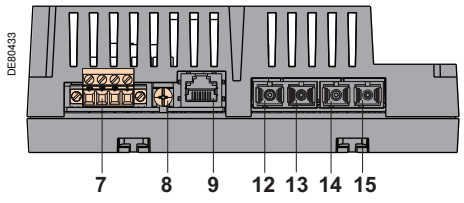
**7** Power-supply terminal block
**8** Grounding/earthing terminal using supplied braid
**9** RJ45 socket to connect the interface to the Sepam base unit with the CCA614 cord:
- ■ Sepam series 40: communication port (C) (identified by a white label on the Sepam unit)
- ■ Sepam series 60 and Sepam series 80: communication port (F) (identified by a blue label on the Sepam unit)

**10** RJ45 10/100 Base TX Ethernet communication port P2 (E-LAN or S-LAN)
**11** RJ45 10/100 Base TX Ethernet communication port P1 (E-LAN or S-LAN)

## ACE850FO communication interface




*ACE850FO: Front view.*




*ACE850FO: View of underside.*

**1** ACE850 communication interface status LED
- ■ LED off = ACE850 de-energized
- ■ Green LED permanently on = ACE850 energized and operational
- ■ Red LED flashing = ACE850 not configured and/or not connected to the base unit
- ■ Red LED permanently on = ACE850 not operational (initialization in progress or failed)

**2** STS LED: communication status: green permanently on = OK
**3** Ethernet Port 2 100 green LED: permanently on = 100 Mbps
**4** Ethernet Port 2 activity LED: flashing on transmission/reception
**5** Ethernet Port 1 100 green LED: permanently on = 100 Mbps
**6** Ethernet Port 1 activity LED: flashing on transmission/reception

**7** Power-supply terminal block
**8** Grounding/earthing terminal using supplied braid
**9** RJ45 socket to connect the interface to the Sepam base unit with a CCA614 cord:
- ■ Sepam series 40: communication port (C) (identified by a white label on the Sepam unit)
- ■ Sepam series 60 and Sepam series 80: communication port (F) (identified by a blue label on the Sepam unit)

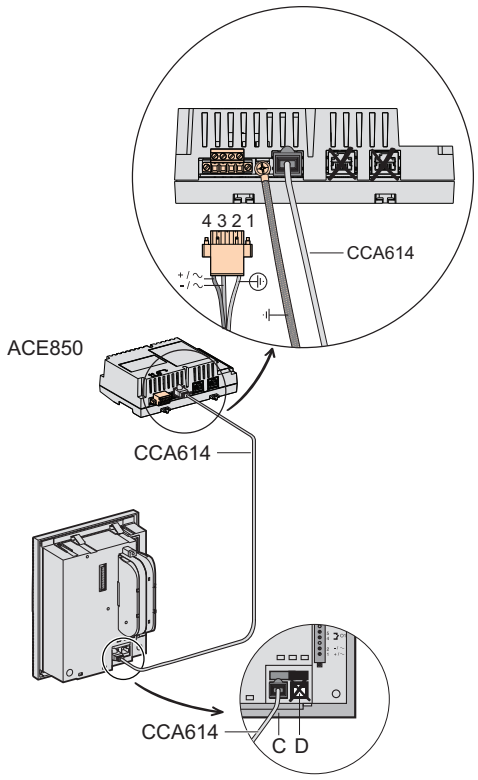
**12** Tx fiber of 100 Base FX SC connector for Ethernet communication port P2 (E-LAN or S-LAN)
**13** Rx fiber of 100 Base FX SC connector for Ethernet communication port P2 (E-LAN or S-LAN)
**14** Tx fiber of 100 Base FX SC connector for Ethernet communication port P1 (E-LAN or S-LAN)
**15** Rx fiber of 100 Base FX SC connector for Ethernet communication port P1 (E-LAN or S-LAN)

**⚠ CAUTION**

**HAZARD OF BLINDING**
Never look directly into the end of the fiber optic.
**Failure to follow these instructions can result in injury.**

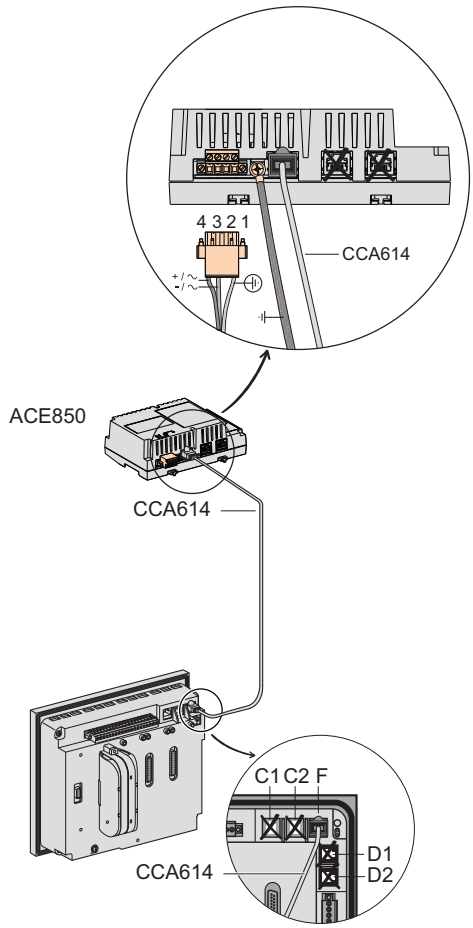
# ACE850TP and ACE850FO Multi-protocol interfaces
Connection

DE80444




*Connecting the ACE850 to Sepam series 40.*

DE80445




*Connecting the ACE850 to Sepam series 60 or series 80.*

## Connection to Sepam

■ The ACE850 communication interface should only be connected to Sepam series 40, Sepam series 60 or series 80 base units using a CCA614 prefabricated cord (length = 3 m or 9.8 ft, blue RJ45 fittings).
■ Sepam series 40: Connect the CCA614 cord to connector (C) on the Sepam base unit (white label).
■ Sepam series 60 or Sepam series 80: Connect the CCA614 cord to connector (F) on the Sepam base unit (blue label).

## Connection of power supply

The ACE850 interfaces must be supplied with 24 to 250 V DC or 110 to 240 V AC.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

■ Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
■ NEVER work alone.
■ Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
■ Always use a properly rated voltage sensing device to confirm that all power is off.
■ Start by connecting the device to the protective ground and to the functional ground.
■ Screw tight all terminals, even those not in use.

**Failure to follow these instructions will result in death or serious injury.**

| Terminal | Assignment | Type | Wiring |
|---|---|---|---|
| 3<br>4 | -/~<br>+/~ | Screw terminals | ■ Wiring without fittings:<br>□ 1 wire with maximum cross-section 0.5 to 2.5 mm² (≥ AWG 20-12)<br>or 2 wires with maximum cross-section 0.5 to 1 mm² (≥ AWG 20-18)<br>□ Stripped length: 8 to 10 mm (0.31 to 0.39 in)<br>■ Wiring with fittings:<br>□ Recommended wiring with Schneider Electric fitting:<br>- DZ5CE015D for 1 wire 1.5 mm² (AWG 16)<br>- DZ5CE025D for 1 wire 2.5 mm² (AWG 12)<br>- AZ5DE010D for 2 wires 1 mm² (AWG 18)<br>□ Tube length: 8.2 mm (0.32 in)<br>□ Stripped length: 8 mm (0.31 in) |
| DE51962 1 ⏚ | Protective earth | Screw terminal | 1 green/yellow wire, max. length 3 m (9.8 ft) and max. cross-section 2.5 mm² (AWG 12) |
| DE51845 ⏚ | Functional earth | 4 mm (0.16 in) ring lug | Earthing braid (supplied) for connection to cubicle grounding |

6

# ACE850TP and ACE850FO Multi-protocol interfaces
Connection

## ACE850TP or ACE850FO communication architectures

### Performance

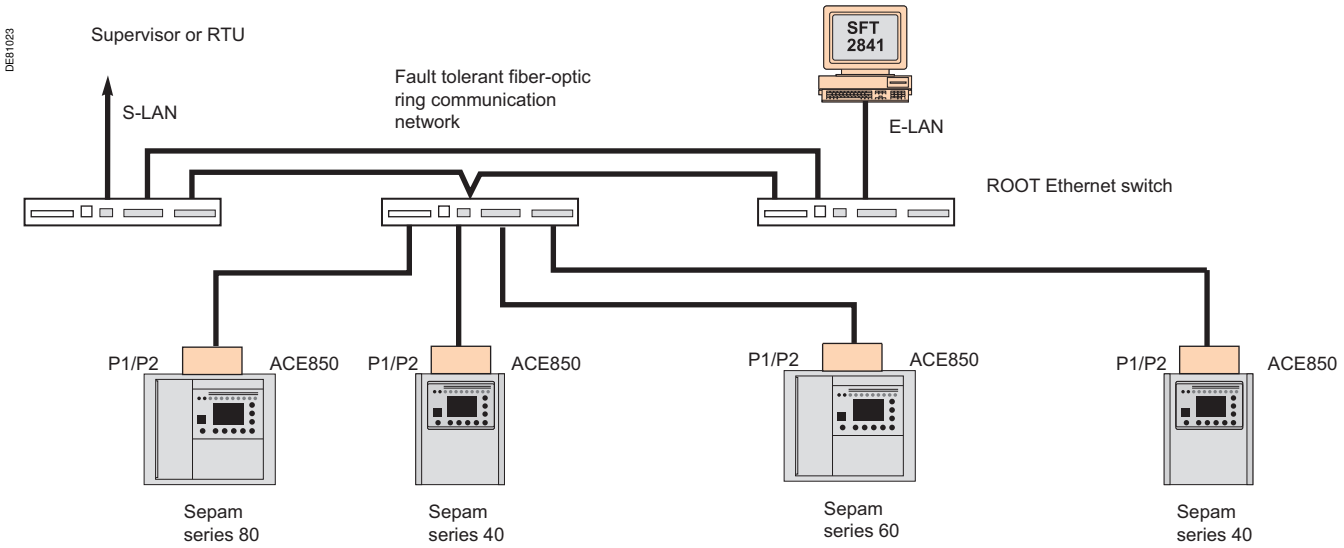
Redundancy performance tests have been conducted using RuggedCom switches (RS900xx, RSG2xxx family), compatible with RSTP 802.1d 2004.
To ensure optimum performance of the protection system during communication between Sepam units via GOOSE messages, we strongly recommend setting up a fault-tolerant fiber-optic ring structure as shown in the connection examples.

***Note:*** *Protection performance during communication between Sepam units via GOOSE message is only ensured by using:*
- *Fiber-optic connections*
- *IEC 61850-compatible managed Ethernet switches*

### ROOT Ethernet switch

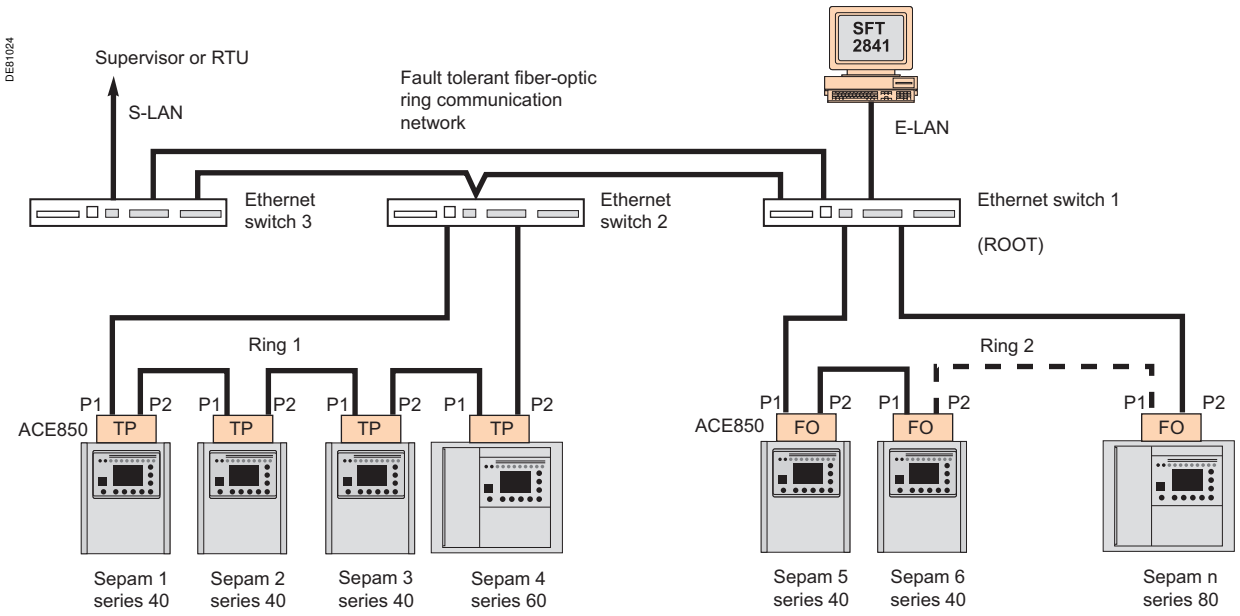
The ROOT Ethernet switch is the master switch of the RSTP reconfiguration function:
- A single ROOT Ethernet switch per Ethernet network, in the main loop of the network
- A Sepam unit must not be the ROOT Ethernet switch of the network

### Example of Sepam units connected in a star configuration



# ACE850TP and ACE850FO Multi-protocol interfaces
## Connection

### Example of Sepam units connected in a ring configuration




### Recommendations for connecting Sepam units in ring configuration

When connecting Sepam units in the same ring configuration, the ACE850 interfaces must be of the same type (either ACE850TP or ACE850FO).
In the worst-case scenario, each Sepam unit must not be separated by more than 30 communicating devices connected to the network (other Sepam units or Ethernet switches) from the ROOT Ethernet switch.
A worst-case analysis must be performed for all the Sepam units in each network topology.
Example:

- In the best-case scenario, Sepam 2 of ring 1 is separated from the ROOT Ethernet switch by 2 devices: switch 2 and Sepam 1.
- In the worst-case scenario, i.e. if the connections between switches 1 and 2 and between Sepam units 1 and 2 of ring 1 are broken, Sepam 2 of ring 1 will be separated from the ROOT Ethernet switch by 4 devices: switch 3, switch 2, Sepam 4 and Sepam 3.

# ACE909-2
# RS 232/RS 485 converter

PE80317

*ACE909-2 RS 232/RS 485 converter.*

## Function

The ACE909-2 converter is used to connect a master/central computer equipped with a V24/RS 232 type serial port as a standard feature to stations connected to a 2-wire RS 485 network.
Without requiring any flow control signals, after the parameters are set, the ACE909-2 converter performs conversion, network polarization and automatic dispatching of frames between the master and the stations by two-way simplex (half-duplex, single-pair) transmission.
The ACE909-2 converter also provides a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam ACE949-2, ACE959 or ACE969-2 interfaces.
The communication settings should be the same as the Sepam and supervisor communication settings.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective earth and to the functional earth.
- Screw tight all terminals, even those not in use.

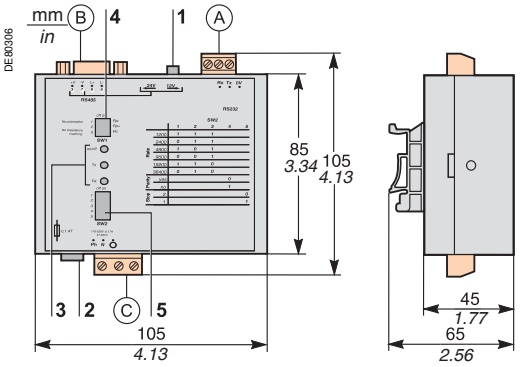
**Failure to follow these instructions will result in death or serious injury.**

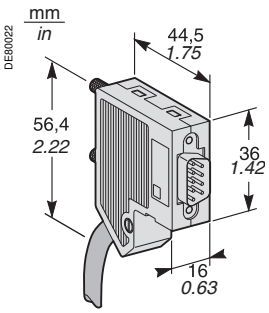
## Characteristics

| Mechanical characteristics | |
|---|---|
| Weight | 0.280 kg (0.617 lb) |
| Assembly | On symmetrical or asymmetrical DIN rail |
| **Electrical characteristics** | |
| Power supply | 110 to 220 V AC ± 10%, 47 to 63 Hz |
| Galvanic isolation between ACE power supply and frame, and between ACE power supply and interface supply | 2000 Vrms, 50 Hz, 1 min |
| Galvanic isolation between RS 232 and RS 485 interfaces | 1000 Vrms, 50 Hz, 1 min |
| Protection by time-delayed fuse 5 mm x 20 mm (0.2 in x 0.79 in) | 1 A rating |
| **Communication and Sepam interface distributed supply** | |
| Data format | 11 bits: 1 start, 8 data, 1 parity, 1 stop |
| Transmission delay | < 100 ns |
| Distributed power supply for Sepam interfaces | 12 V DC or 24 V CC, 250 mA max. |
| Maximum number of Sepam interfaces with distributed supply | 12 |
| **Environmental characteristics** | |
| Operating temperature | -5°C to +55°C (+23°F to +131°F) |

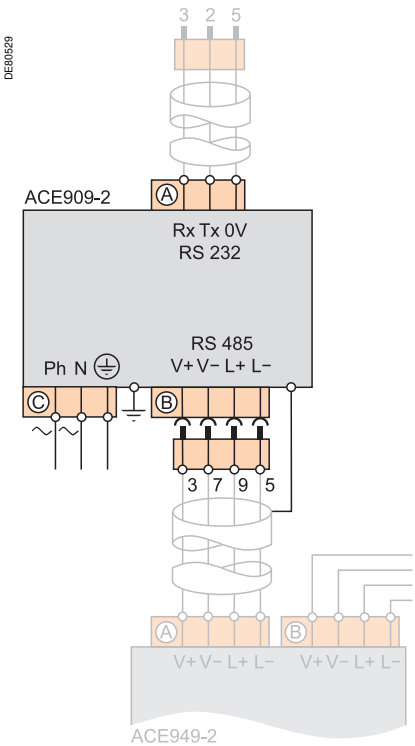
| Electromagnetic compatibility | IEC standard | Value |
|---|---|---|
| Fast transient bursts, 5 ns | 60255-22-4 | 4 kV with capacitive coupling in common mode<br>2 kV with direct coupling in common mode<br>1 kV with direct coupling in differential mode |
| 1 MHz damped oscillating wave | 60255-22-1 | 1 kV common mode<br>0.5 kV differential mode |
| 1.2/50 µs impulse waves | 60255-5 | 3 kV common mode<br>1 kV differential mode |

# ACE909-2
# RS 232/RS 485 converter




*Male 9-pin sub-D connector supplied with the ACE909-2.*




## Description and dimensions

(A) Terminal block for RS 232 link limited to 10 m (33 ft).

(B) Female 9-pin sub-D connector to connect to the 2-wire RS 485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.

(C) Power-supply terminal block

**1** Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
**2** Protection fuse, unlocked by a 1/4 turn.
**3** LEDs:
- ON/OFF: on if ACE909-2 is energized
- Tx: on if RS 232 sending by ACE909-2 is active
- Rx: on if RS 232 receiving by ACE909-2 is active.

**4** SW1, parameter setting of 2-wire RS 485 network polarization and line impedance matching resistors.

| Function | SW1/1 | SW1/2 | SW1/3 |
|---|---|---|---|
| Polarization at 0 V via Rp -470 Ω | ON | | |
| Polarization at 5 V via Rp +470 Ω | | ON | |
| 2-wire RS 485 network impedance matching by 150 Ω resistor | | | ON |

**5** SW2, parameter setting of asynchronous data transmission rate and format (same parameters as for RS 232 link and 2-wire RS 485 network).

| Rate (bauds) | SW2/1 | SW2/2 | SW2/3 | | |
|---|---|---|---|---|---|
| 1200 | 1 | 1 | 1 | | |
| 2400 | 0 | 1 | 1 | | |
| 4800 | 1 | 0 | 1 | | |
| 9600 | 0 | 0 | 1 | | |
| 19200 | 1 | 1 | 0 | | |
| 38400 | 0 | 1 | 0 | | |
| **Format** | | | | **SW2/4** | **SW2/5** |
| With parity check | | | | 0 | |
| Without parity check | | | | 1 | |
| 1 stop bit (compulsory for Sepam) | | | | | 1 |
| 2 stop bits | | | | | 0 |

**Converter configuration when delivered**
- 12 V DC distributed power supply
- 11-bit format, with parity check
- 2-wire RS 485 network polarization and impedance matching resistors activated.

## Connection

**RS 232 link**
- To 2.5 mm² (AWG 12) screw type terminal block (A)
- Maximum length 10 m (33 ft)
- Rx/Tx: RS 232 receiving/sending by ACE909-2
- 0V: Rx/Tx common, do not earth.

**2-wire RS 485 link with distributed power supply**
- To connector (B) female 9-pin sub-D
- 2-wire RS 485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

**Power supply**
- To 2.5 mm² (AWG 12) screw type terminal block (C)
- Reversible phase and neutral
- Earthed via terminal block and metal case (ring lug on back of case).

# ACE919CA and ACE919CC RS 485/RS 485 converters

PE80316

*ACE919CC RS 485/RS 485 converter.*

## Function

The ACE919 converters are used to connect a master/central computer equipped with an RS 485 type serial port as a standard feature to stations connected to a 2-wire RS 485 network.
Without requiring any flow control signals, the ACE919 converters perform network polarization and impedance matching.
The ACE919 converters also provide a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam ACE949-2, ACE959 or ACE969-2 interfaces.
There are 2 types of ACE919 converter:

- ACE919CC, DC-powered
- ACE919CA, AC-powered.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective earth and to the functional earth.
- Screw tight all terminals, even those not in use.

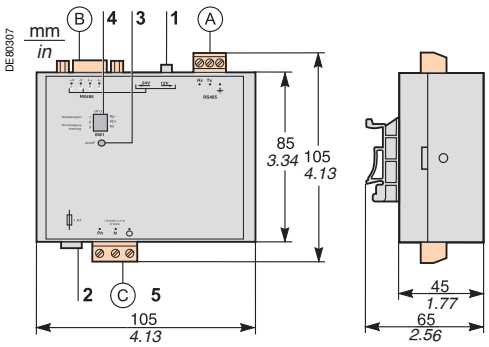
**Failure to follow these instructions will result in death or serious injury.**

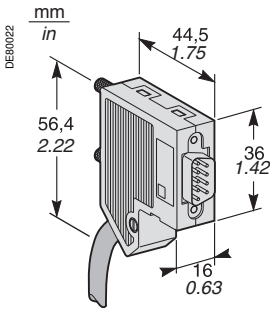
## Characteristics

| Mechanical characteristics | | |
|---|---|---|
| Weight | 0.280 kg (0.617 lb) | |
| Assembly | On symmetrical or asymmetrical DIN rail | |
| **Electrical characteristics** | **ACE919CA** | **ACE919CC** |
| Power supply | 110 to 220 V AC ±10%, 47 to 63 Hz | 24 to 48 V DC ±20% |
| Protection by time-delayed fuse 5 mm x 20 mm (0.2 in x 0.79 in) | 1 A rating | 1 A rating |
| Galvanic isolation between ACE power supply and frame, and between ACE power supply and interface supply | | 2000 Vrms, 50 Hz, 1 min |
| **Communication and Sepam interface distributed supply** | | |
| Data format | 11 bits: 1 start, 8 data, 1 parity, 1 stop | |
| Transmission delay | < 100 ns | |
| Distributed power supply for Sepam interfaces | 12 V DC or 24 V CC, 250 mA max. | |
| Maximum number of Sepam interfaces with distributed supply | 12 | |
| **Environmental characteristics** | | |
| Operating temperature | -5°C to +55°C (+23°F to +131°F) | |
| **Electromagnetic compatibility** | **IEC standard** | **Value** |
| Fast transient bursts, 5 ns | 60255-22-4 | 4 kV with capacitive coupling in common mode<br>2 kV with direct coupling in common mode<br>1 kV with direct coupling in differential mode |
| 1 MHz damped oscillating wave | 60255-22-1 | 1 kV common mode<br>0.5 kV differential mode |
| 1.2/50 µs impulse waves | 60255-5 | 3 kV common mode<br>1 kV differential mode |

# ACE919CA and ACE919CC RS 485/RS 485 converters

## Description and dimensions




*Male 9-pin sub-D connector supplied with the ACE919.*

Ⓐ Terminal block for 2-wire RS 485 link without distributed power supply.

Ⓑ Female 9-pin sub-D connector to connect to the 2-wire RS 485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.

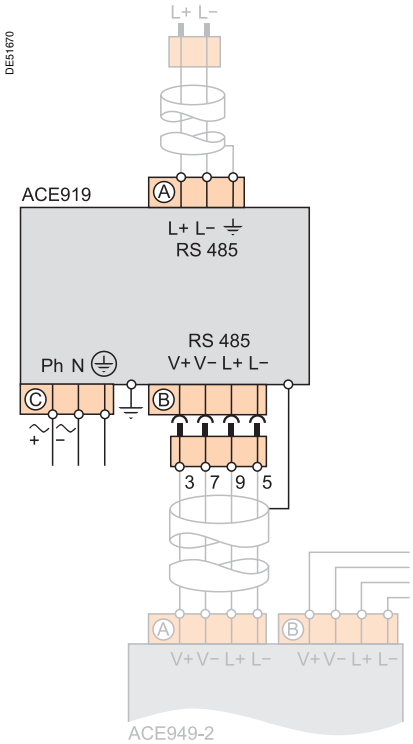
Ⓒ Power supply terminal block.

**1** Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
**2** Protection fuse, unlocked by a 1/4 turn.
**3** ON/OFF LED: on if ACE919 is energized.
**4** SW1, parameter setting of 2-wire RS 485 network polarization and line impedance matching resistors.

| Function | SW1/1 | SW1/2 | SW1/3 |
|---|---|---|---|
| Polarization at 0 V via Rp -470 Ω | ON | | |
| Polarization at 5 V via Rp +470 Ω | | ON | |
| 2-wire RS 485 network impedance matching by 150 Ω resistor | | | ON |

**Converter configuration when delivered**
- 12 V DC distributed power supply
- 2-wire RS 485 network polarization and impedance matching resistors activated.

## Connection




**2-wire RS 485 link without distributed power supply**
- To 2.5 mm² (AWG 12) screw type terminal block Ⓐ
- L+, L-: 2-wire RS 485 signals
- ⏚ Shielding.

**2-wire RS 485 link with distributed power supply**
- To connector Ⓑ female 9-pin sub-D
- 2-wire RS 485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

**Power supply**
- To 2.5 mm² (AWG 12) screw type terminal block Ⓒ
- Reversible phase and neutral (ACE919CA)
- Earthed via terminal block and metal case (ring lug on back of case).

# ECI850
# IEC 61850 Sepam server

PE80319

*ECI850: IEC 61850 Sepam server.*

## Function

The ECI850 can be used to connect Sepam series 20, Sepam series 40, Sepam series 60 and Sepam series 80 to an Ethernet network using the IEC 61850 protocol.
The ECI850 creates the interface between the Ethernet/IEC 61850 network and a Sepam RS 485/Modbus network.
A PRI surge arrester (ref. 16339) is supplied with the ECI850 to protect its power supply.

## Compatible Sepam

The ECI850 servers are compatible with the following Sepam:
- Sepam series 20 version ⩾ V0526
- Sepam series 40 version ⩾ V3.00
- Sepam series 60 all versions
- Sepam series 80 base version and application version ⩾ V3.00.

## Characteristics

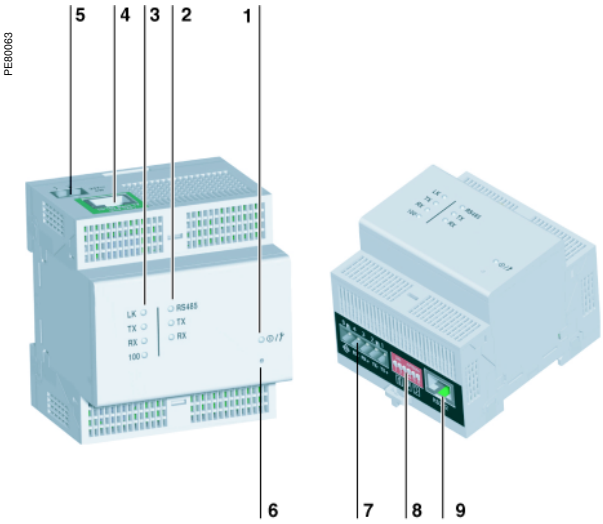
| | |
|---|---|
| **ECI850 module** | |
| **Technical characteristics** | |
| Weight | 0.17 kg (0.37 lb) |
| Assembly | On symmetrical DIN rail |
| **Power supply** | |
| Voltage | 24 V DC (± 10%) supplied by a class 2 power supply |
| Maximum consumption | 4 W |
| Dielectric withstand | 1.5 kV |
| **Environmental characteristics** | |
| Operating temperature | -25 °C to +70 °C (-13 °F to +158 °F) |
| Storage temperature | -40 °C to +85 °C (- 40 °F to +185 °F) |
| Humidity ratio | 5 to 95% relative humidity (non condensing) at +55 °C (131 °F) |
| Degree of pollution | Class 2 |
| Tightness | IP30 |
| **Electromagnetic compatibility** | |
| **Emission tests** | |
| Emissions (radiated and conducted) | EN 55022/EN 55011/FCC Class A |
| **Immunity tests - Radiated disturbances** | |
| Electrostatic discharge | EN 61000-4-2 |
| Radiated radiofrequencies | EN 61000-4-3 |
| Magnetic fields at the network frequency | EN 61000-4-8 |
| **Immunity tests - Conducted disturbances** | |
| Fast transient bursts | EN 61000-4-4 |
| Surges | EN 61000-4-5 |
| Conducted radiofrequencies | EN 61000-4-6 |
| **Safety** | |
| International | IEC 60950 |
| USA | UL 508/UL 60950 |
| Canada | cUL (complies with CSA C22.2, no. 60950) |
| Australia/New Zealand | AS/NZS 60950 |
| **Certification** | |
| Europe | CE |
| **2-wire/4-wire RS 485 communication port** | |
| **Electrical interface** | |
| Standard | 2-wire or 4-wire differential RS 485 EIA |
| Max. number of Sepam units per ECI850 | 2 Sepam series 80 or<br>2 Sepam series 60 or<br>3 Sepam series 40 or<br>5 Sepam series 20 |
| Maximum network length | 1000 m (3300 ft) |
| **Ethernet communication port** | |
| Number of ports | 1 |
| Type of port | 10/100 Base Tx |
| Protocols | HTTP, FTP, SNMP, SNTP, ARP, SFT, IEC 61850 TCP/IP |
| Transmission speed | 10/100 Mbps |

# ECI850
# IEC 61850 Sepam server

## Characteristics (cont'd)

| PRI surge arrester | |
|---|---|
| **Electrical characteristics** | |
| Nominal operating voltage | 48 V DC |
| Maximum discharge current | 10 kA (8/20 µs wave) |
| Nominal discharge current | 5 kA (8/20 µs wave) |
| Protection level | 70 V |
| Response time | 1 ns |
| **Connection** | |
| With cage terminals | Cables with cross-section 2.5 to 4 mm² (AWG 12-10) |

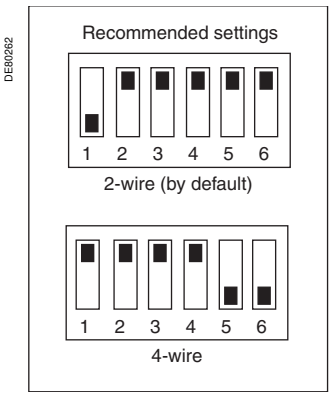
## Description




**1** ⓘ/🔧 LED: power-up/maintenance
**2** Standard LEDs:
- ■ RS 485 LED: network link active
- □ On: RS 485 mode
- □ Off: RS 232 mode
- ■ Flashing green Tx LED: ECI850 transmission active
- ■ Flashing green Rx LED: ECI850 reception active

**3** Ethernet LEDs:
- ■ LK green LED on: network link active
- ■ Flashing green Tx LED: ECI850 transmission active
- ■ Flashing green Rx LED: ECI850 reception active
- ■ 100 green LED:
- □ On: 100 Mbps network speed
- □ Off: 10 Mbps network speed

**4** 10/100 Base Tx port for Ethernet connection by RJ45 connector
**5** Connection of the 24 V DC supply
**6** Reset button
**7** RS 485 connection
**8** RS 485 parameter-setting selector switches
**9** RS 232 connection




*Setting the RS 485 network parameters.*

### Setting the RS 485 network parameters

The network polarization and line impedance matching resistors and type of 2-wire/ 4-wire RS 485 network are selected by means of the RS 485 parameter-setting selector switches. These selector switches are configured by default for a 2-wire RS 485 network with network polarization and line impedance matching resistors.

| Network line impedance matching with resistor | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 |
|---|---|---|---|---|---|---|
| 2-wire RS 485 | OFF | ON | | | | |
| 4-wire RS 485 | ON | ON | | | | |

| Network polarization | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 |
|---|---|---|---|---|---|---|
| at the 0 V | | | ON | | | |
| at the 5 V | | | | ON | | |

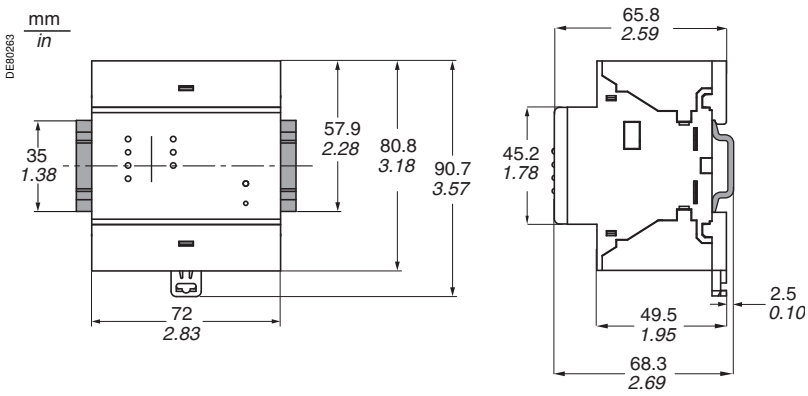
| Selecting the RS 485 network | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 |
|---|---|---|---|---|---|---|
| 2-wire network | | | | | ON | ON |
| 4-wire network | | | | | OFF | OFF |

### Setting the Ethernet link parameters

The TCSEAK0100 configuration kit can be used to connect a PC to the ECI850 to set the Ethernet link parameters.

# ECI850
# IEC 61850 Sepam server

## Dimensions




## CAUTION

**RISK OF DESTRUCTION OF THE ECI850**

■ Connect the PRI surge arrester in accordance with the wiring diagrams below.

■ Check the quality of the earth connected to the surge arrester.

**Failure to follow these instructions can result in equipment damage.**

## Connection

■ Connect the power supply and RS 485 twisted pair using cable with cross-section ⩽ 2.5 mm² (⩾AWG 12)

■ Connect the 24 V DC power supply and the earth to inputs (1), (5) and (3) of the PRI surge arrester (ref. 16339) supplied with the ECI850

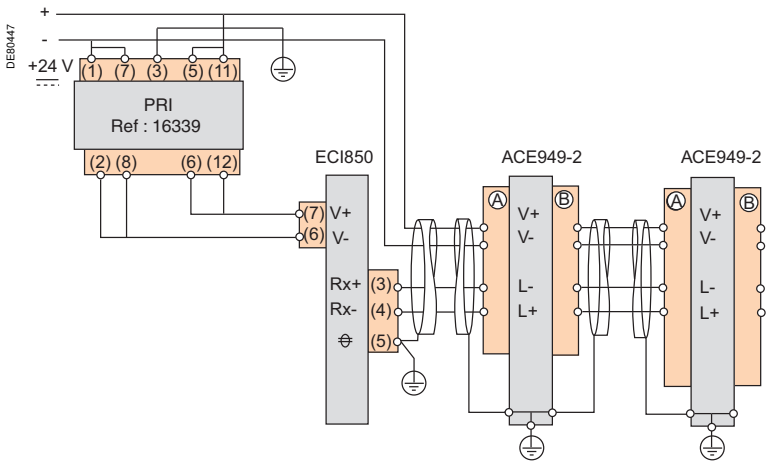
■ Connect outputs (2), (8) and (6), (12) of the PRI surge arrester to the - and + terminals of the black screen terminal block

■ Connect the RS 485 twisted pair (2-wire or 4-wire) to the (RX+ RX- or RX+ RX- TX+ TX-) terminals of the black screw terminal block

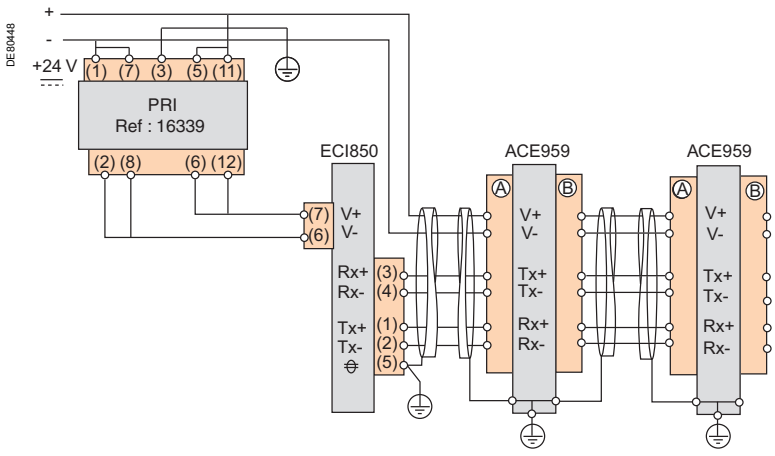
■ Connect the RS 485 twisted pair shielding to the ⏚ terminal of the black screw terminal block

■ Connect the Ethernet cable to the green RJ45 connector

**2-wire RS 485 network**




**4-wire RS 485 network**

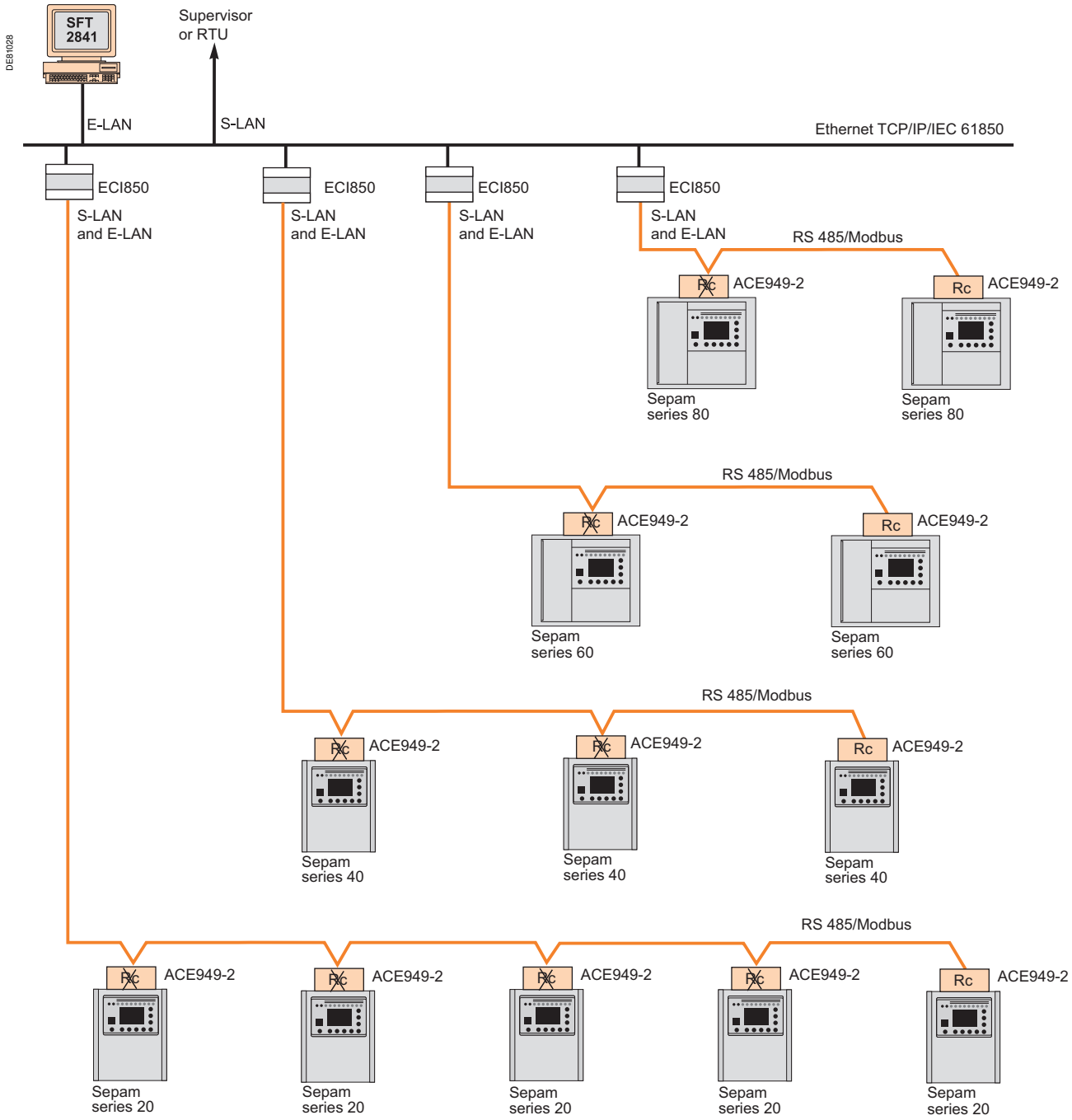


# ECI850
# IEC 61850 Sepam server

## Example of architecture

The diagram below shows an example of the communication architecture with ECI850 IEC 61850 Sepam servers.

***Note:*** *Rc, line impedance matching resistor*




## Maximum Advised Configuration

The maximum configuration of Sepam for an ECI850 IEC 61850 Sepam server of level 1 is to be choosen between the following configurations:

- 5 Sepam series 20,
- 3 Sepam series 40,
- 2 Sepam series 60,
- 2 Sepam series 80.

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# User Machine Interfaces

## Sepam User Machine Interfaces

Two different levels of user machine interface (UMI) are offered on the front panel of Sepam:

- Basic UMI, with LEDs, for installations operated via a remote system with no need for local operation
- Advanced UMI, with keypad and graphic LCD display, giving access to all the infor11mation necessary for local operation and Sepam parameter setting.

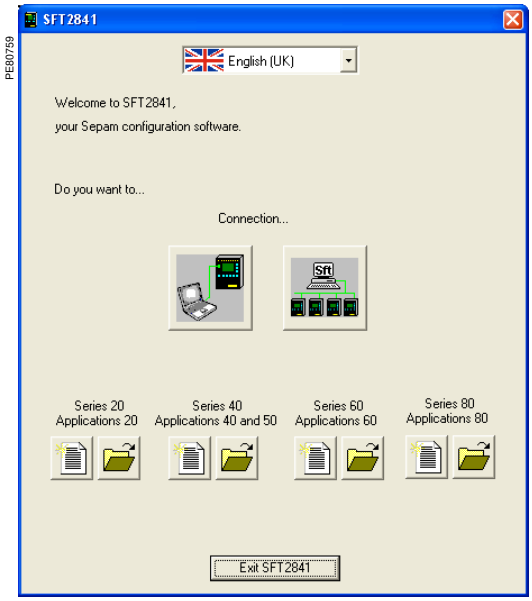
## SFT2841 setting and operating software

The UMI on the front panel of Sepam can be completed by the SFT2841 PC software tool, which can be used for all Sepam parameter setting, local operation and customization functions.

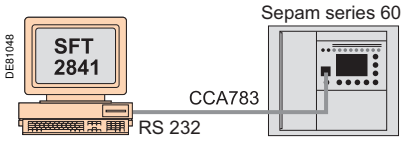
The SFT2841 setting and operating software is supplied on CD-ROM, along with the SFT2826 program for recovering disturbance recording files, the interactive introduction to the Sepam range, and all the Sepam documentation in PDF format.

The CCA783 or CCA784 PC connecting cord, to be ordered separately, connects the PC to the port on the Sepam front panel, so that the SFT2841 package can be used in point-to-point connected mode.

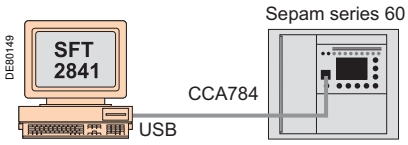
# SFT2841 setting and operating software
## Welcome window



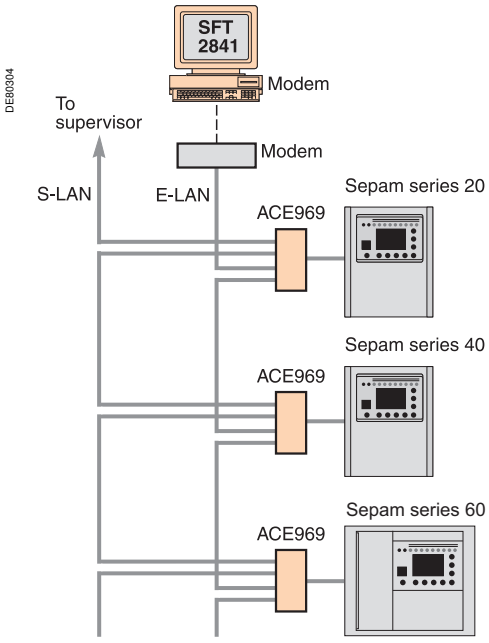

*Welcome window.*




*SFT2841 connected to a single Sepam unit with the serial port.*




*SFT2841 connected to a single Sepam unit with the USB port.*




*SFT2841 connected to a Sepam network.*

### Description

The SFT2841 welcome window opens when the program is launched.
It lets you choose the language for the SFT2841 screens, and provides access to the Sepam parameter and protection setting files:
- In disconnected mode, you can open or create a parameter and protection setting file for a Sepam
- When connected to a single Sepam unit, you can access the parameter and protection setting file for the Sepam unit connected to the PC
- When connected to a Sepam network, you can access the parameter and protection setting files for a group of Sepam units connected to the PC via a communication network.

### Language of SFT2841 screens

SFT2841 software can be used in English, French or Spanish. The language is selected at the top of the window.

### Using SFT2841 in disconnected mode

Disconnected mode allows you to prepare parameters and settings files for Sepam prior to commissioning.
The parameter and protection setting files prepared in disconnected mode will be downloaded later to the Sepam units in connected mode.
- To create a new parameter and protection setting file, click on the icon for the relevant Sepam family
- To open an existing parameter and protection setting file, click on the icon for the relevant Sepam family.

### Using SFT2841 connected to a single Sepam unit

Connected to a single Sepam unit mode is used during commissioning:
- To upload, download and modify Sepam parameters and settings
- To have all the measurements and supporting data available for commissioning.

The PC fitted with the SFT2841 software is connected to the port on the front panel of the Sepam via an RS 232 port using the CCA783 cord or via an USB port using the CCA784 cord.
To open the parameter and protection setting file on the Sepam once it is connected to the PC, click on the icon.

### Using SFT2841 connected to a Sepam network

Connected to a Sepam network mode is used during operation:
- To manage the protection system
- To check the status of the power supply
- To diagnose any incident occurring on the power supply.

The PC fitted with the SFT2841 software is connected to a group of Sepam units via a communication network (connection via serial link, telephone line or Ethernet). This network forms the E-LAN engineering network.

The connection window allows configuration of the Sepam network, and provides access to the parameter and protection setting files of the Sepam units on the network.

To open the connection window, click on the icon.

See “Configuration of a Sepam network” page 273 for details of how to configure the E-LAN engineering network from the connection window.

# SFT2841 setting and operating software
## Presentation

All the setting and operating functions are available on the screen of a PC equipped with the SFT2841 software tool and connected to the PC connection on the front panel of Sepam (run in a Windows XP or Vista environment).
All the data used for the same task are grouped together in the same screen to facilitate operation. Menus and icons are used for fast, direct access to the required information.

**Current operation**
- display of all metering and operation data
- display of alarm messages with the time of appearance (date, hour, mn, s, ms)
- display of diagnosis data such as: tripping current, number of switchgear operations and cumulative breaking current
- display of all the protection and parameter settings
- display of the logic status of inputs, outputs and signal lamps.

The SFT2841 software is the solution suited to occasional local operation, for demanding personnel who require fast access to all the information.

**Parameter and protection setting (1)**
- display and setting of all the parameters of each protection function in the same page
- program logic parameter setting, parameter setting of general installation and Sepam data
- input data may be prepared ahead of time and transferred into the corresponding Sepam units in a single operation (downloading function).

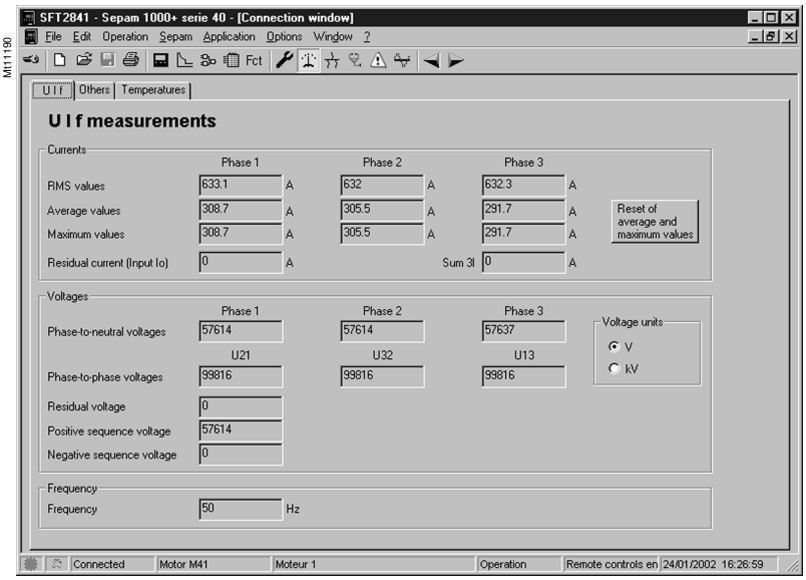
Main functions performed by SFT2841:
- changing of passwords
- entry of general characteristics (ratings, integration period, …)
- setting Sepam date and time
- entry of protection settings
- changing of program logic assignments
- enabling/disabling of functions
- saving of files.

**Saving**
- protection and parameter setting data may be saved
- printing of reports is possible as well.

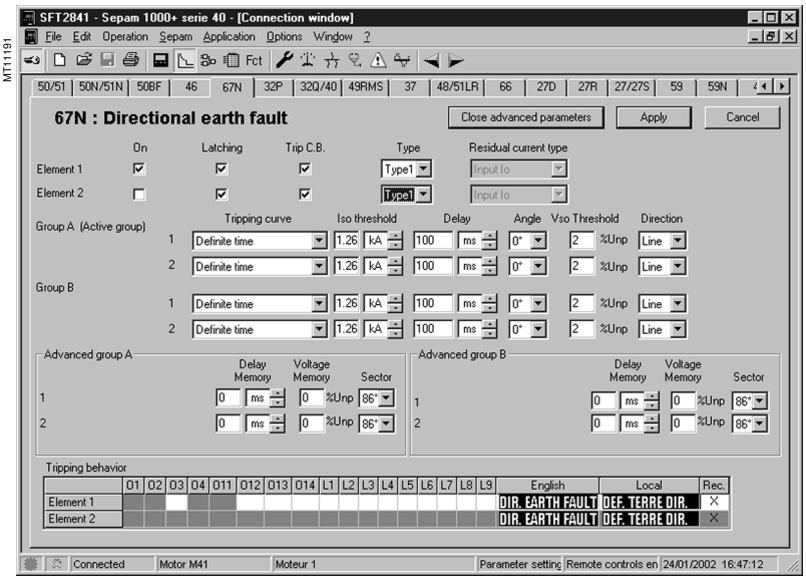
The SFT2841 software may also be used to recover disturbance recording files and provide graphic display using the SFT2826 software tool.

**Operating assistance**
Access from all the screens to a help section which contains all the technical data required for Sepam installation and use.

***(1)** Modes accessed via 2 passwords (protection setting level, parameter setting level).*




*Example of a measurement display screen.*




*Example of a protection setting screen.*

# SFT2841 setting and operating software
## General screen organization

A Sepam document is displayed on the screen via a graphic interface that has the conventional Windows features.
All the SFT2841 software screens are set up in the same way, i.e.:
■ Ⓐ: title bar, with:
□ name of the application (SFT2841)
□ identification of the Sepam document displayed
□ window manipulation handles
■ Ⓑ: menu bar, to access all the SFT2841 software functions (unavailable functions are dimmed)
■ Ⓒ: toolbar, a group of contextual icons for quick access to the main functions (also accessed via the menu bar)
■ Ⓓ: work zone available to the user, presented in the form of tab boxes
■ Ⓔ: status bar, with the following information relating to the active document:
□ alarm on
□ identification of the connection window
□ SFT2841 operating mode, connected or not connected,
□ type of Sepam
□ Sepam editing identification
□ identification level
□ Sepam operating mode
□ PC date and time.

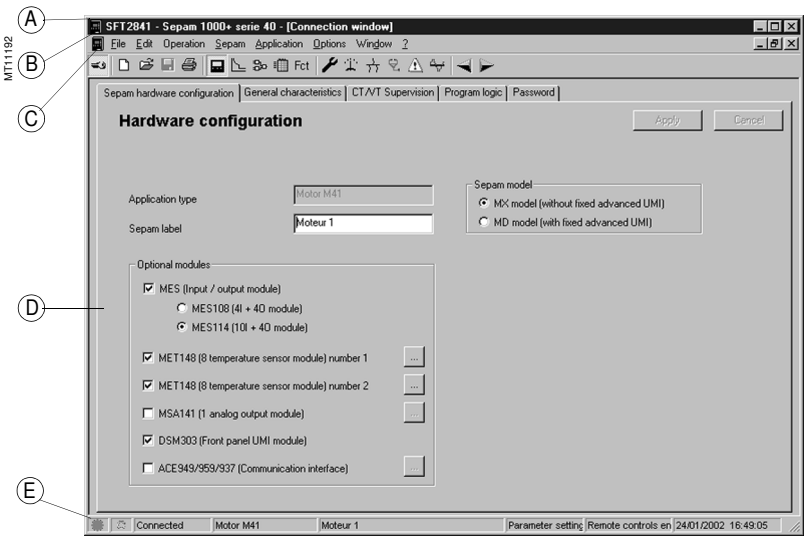
### Guided navigation

A guided navigation mode is proposed to make it easier to enter all of the Sepam parameter and protection settings. It allows users to go through all the data input screens in the natural order.
The sequencing of the screens in guided mode is controlled by clicking on 2 icons in the toolbar Ⓒ:
■ ◀: to go back to the previous screen
■ ▶: to go to the next screen.

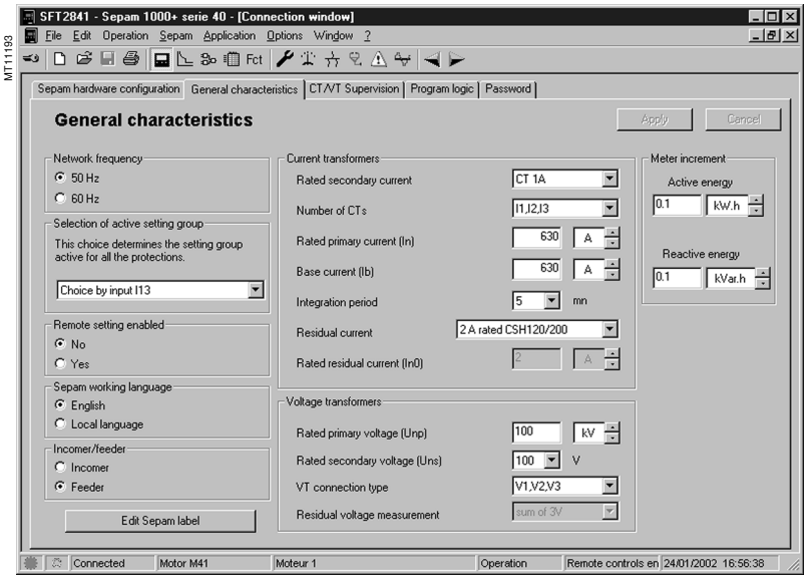
The screens are linked up in the following order:
1. Sepam hardware configuration
2. General characteristics
3. CT/VT supervision
4. Program logic
5. Password
6. Setting screens for the protection functions available, according to the type of Sepam
7. Logical equation editor
8. Various tabs of the control matrix
9. Disturbance recording setup.

### On-line help

The operator may look up on-line help at any time via the "?" command in the menu bar.
To use the on-line help, a browser such as Netscape Navigator or Internet Explorer MS is required.




*Example of Sepam configuration screen.*




*Example of general characteristics screen.*

## Not connected to Sepam mode

**Sepam parameter and protection setting**

The parameter and protection setting of a Sepam using SFT2841 consists of preparing the Sepam file containing all the characteristics that are specific to the application, a file that is then downloaded into Sepam at the time of commissioning.

**CAUTION**

**HAZARD OF UNINTENDED OPERATION**

- The device must only be configured and set by qualified personnel, using the results of the installation protection system study.
- During commissioning of the installation and after any modification, check that the Sepam configuration and protection function settings are consistent with the results of this study.

**Failure to follow these instructions can result in equipment damage.**

Operating mode:

1. Create a Sepam file for the type of Sepam to be set up (the newly created file contains the Sepam factory-set parameter and protection settings).
2. Modify the Sepam general settings and protection function settings:

- all the data relating to the same function are grouped together in the same screen
- it is advisable to enter all the parameters and protection settings in the natural order of the screens proposed by the guided navigation mode.

**Entry of parameter and protection settings:**

- the parameter and protection setting input fields are suited to the type of value:
  - choice buttons
  - numerical value input fields
  - dialogue box (Combo box)
- the user must "Apply" or "Cancel" the new values entered before going on to the following screen
- the consistency of the new values applied is checked:
  - an explicit message identifies inconsistent values and specifies the authorized values
  - values that have become inconsistent following a parameter modification are adjusted to the closest consistent value.

## Connected to Sepam mode

**Precaution**

When a laptop is used, given the risks inherent to the accumulation of static electricity, the customary precaution consists of discharging in contact with an earthed metal frame before physically connecting the CCA783 cord.

***Note:*** *If you are unable to connect to Sepam, check that the SFT2841 software version used is actually compatible with your Sepam.*
*(see "Compatibility of Sepam version/SFT2841 version" page 303).*

**Plugging into Sepam**

- plugging of the 9-pin connector (SUB-D type) into one of the PC communication ports. Configuration of the PC communication port via the "Communication port" function in the "Options" menu
- plugging of the 6-pin connector into the connector (round minidin type) situated behind the blanking plate on the front panel of Sepam or the DSM303 module.

**Connection to Sepam**

2 possibilities for setting up the connection between SFT2841 and Sepam:

- "Connection" function in the "File" menu
- choice of "connect to the Sepam" at the start-up of SFT2841.

Once the connection with Sepam has been established, "Connected" appears in the status bar, and the Sepam connection window may be accessed in the work zone.

**User identification**

The window intended for the entry of the 4-digit password is activated:

- via the "Passwords" tab
- via the "Identification" function in the "Sepam" menu
- via the "Identification" icon .

The "Return to Operating mode" function in the "Passwords" tab removes access rights to parameter and protection setting mode.

**Downloading of parameters and protection settings**

Parameter and protection setting files may only be downloaded in the connected Sepam in Parameter setting mode.

Once the connection has been established, the procedure for downloading a parameter and protection setting file is as follows:

1. Activate the "Download Sepam" function in the "Sepam" menu.
2. Select the file (*.S40, *.S41, *.S42, *.S43, *.S44, *.S50, *.S51, *.S52, *.S53, *.S54 *.T40, *.T42, *.T50, *.T52, *.M40, *.M41, *.G40 according to the type of application) which contains the data to be downloaded.

**Return to factory settings**

This operation is only possible in Parameter setting mode, via the "Sepam" menu. All of the Sepam general characteristics, protection settings and the control matrix go back to the default values.

**Uploading of parameter and protection settings**

The connected Sepam parameter and protection setting file may only be uploaded in Operating mode.

Once the connection has been established, the procedure for uploading a parameter and protection setting file is as follows:

1. Activate the "Upload Sepam" function in the "Sepam" menu.
2. Select the *.rpg file that is to contain the uploaded data.
3. Acknowledge the end of operation report.

**Local operation of Sepam**

Connected to Sepam, SFT2841 offers all the local operating functions available in the advanced UMI screen, plus the following functions:

- setting of Sepam internal clock, via the "general characteristics" tab
- implementation of the disturbance recording function, via the "Fault recording" menu "OPG": validation/inhibition of the function, recovery of Sepam files, start-up of SFT2826
- consultation of the history of the last 64 Sepam alarms, with time-tagging
- access to Sepam diagnostic data, in the "Sepam" tab box, included in ""Sepam diagnosis"
- in Parameter setting mode, the switchgear diagnostic values may be modified: operation counter, cumulative breaking current to reset the values after a change of breaking device.

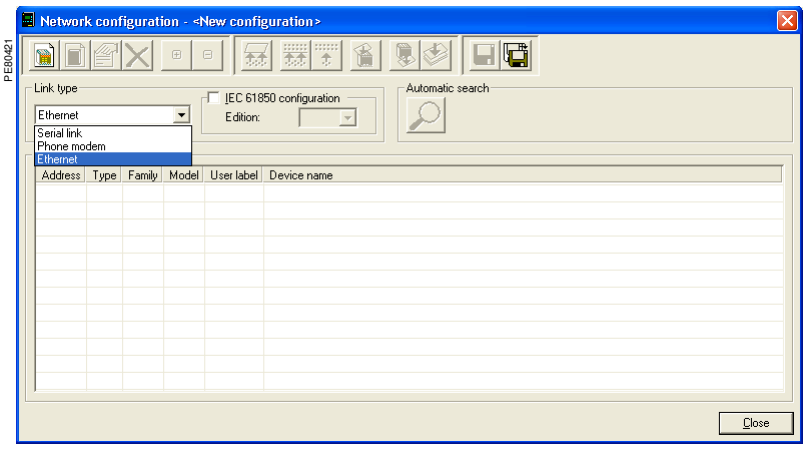
# SFT2841 setting and operating software
## Configuration of a Sepam network

### Connection window
The SFT2841 software connection window is used:
- To select an existing Sepam network or configure a new one
- To set up the connection to the selected Sepam network
- To select one Sepam unit from the network and access its parameters, settings, and operation and maintenance information.

### Configuration of a Sepam network
Several configurations can be defined for the various Sepam installations.
A Sepam network configuration is identified by a name. It is saved on the SFT2841 PC in a file in the SFT2841 installation directory (default: C:\Program Files\Schneider\SFT2841\Net).

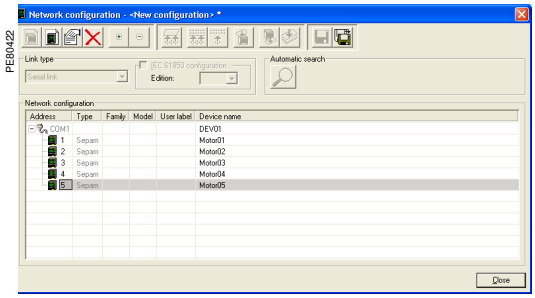
Configuration of a Sepam network is in 2 parts:
- Configuration of the communication network
- Configuration of the Sepam units.

### Configuration of the communication network
To configure the communication network, first define:
- The type of link between the PC and the Sepam network
- The communication parameters, according to the type of link selected:
  - direct serial link
  - link via Ethernet TCP/IP
  - link via telephone modem.




*Configuration windows for the communication network, according to the type of link: serial link, modem link (STN) or Ethernet link (TCP).*

# SFT2841 setting and operating software
## Configuration of a Sepam network

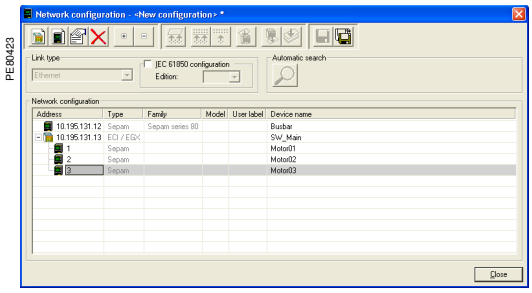



*Configuration window for the serial link communication network.*

### Direct serial link

The Sepam units are connected to an RS 485 (or fiber-optic) multidrop network. Depending on the serial link interfaces available on the PC, the PC itself will be connected either directly to the RS 485 network (or fiber-optic HUB), or via an RS 232/RS 485 converter (or fiber-optic converter).

The communication parameters to be defined are:
- port: communication port used on the PC
- speed: 4800, 9600, 19200 or 38400 bauds
- parity: None, Even or Odd
- handshake: None, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.
- number of retries: from 1 to 6.




*Configuration window for the Ethernet TCP/IP communication network.*

### Link via TCP/IP Ethernet

The Sepam units are connected to an RS 485 multidrop network over one or more Ethernet Modbus TCP/IP gateways (for example: EGX gateways or ECI850 servers that act as the Modbus TCP/IP gateway for the link with the SFT2841).

**Use on an IEC 61850 network**

SFT2841 can be used on an IEC 61850 network. In this case, it can be used to define the IEC 61850 configuration of Sepam connected to this network. See the Sepam IEC 61850 Communication user's manual (reference SEPED306024EN) for more information.

**Configuration of the Modbus TCP/IP gateway**

See the setup manual for the gateway used.
In general, the gateway should be assigned an IP address.
The configuration parameters for the gateway's RS 485 interface must be defined in accordance with the Sepam communication interface configuration:
- speed: 4800, 9600, 19200 or 38400 bauds
- character format: 8 data bits + 1 stop bit + parity (none, even, odd).

**Configuration of communication on SFT2841**

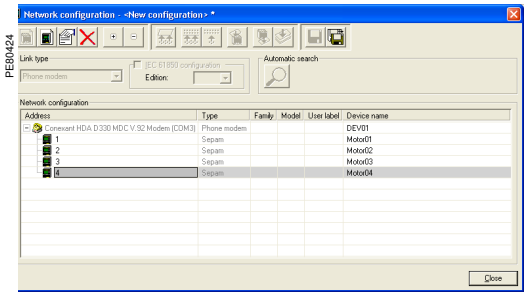
When configuring a Sepam network on SFT2841, the following communication parameters must be defined:
- type of device: Modbus gateway, ECI850 or Sepam
- IP address: IP address for the connected remote equipment
- time-out: from 100 to 3000 ms.

A time-out of between 800 ms and 1000 ms is sufficient in most installations.
Communication via the TCP/IP gateway may, however, be slowed down if other applications want Modbus TCP/IP or IEC 61850 access at the same time.
The time-out value should then be increased (2 to 3 seconds).
- number of retries: from 1 to 6.

***Note 1:*** *SFT2841 uses the Modbus TCP/IP communication protocol.*
*Although communication is IP-based, use of SFT2841 is restricted to a local installation network based on an Ethernet network (LAN – Local Area Network).*
*The operation of SFT2841 over a WAN (Wide Area Network) cannot be guaranteed because of the presence of some routers or firewalls that may reject the Modbus protocol, causing communication times that would be incompatible with Sepam.*

***Note 2:*** *SFT2841 allows Sepam protection settings to be modified, and direct activation of the outputs. These operations, which could involve the operation of electrical switchgear (opening and closing), and thus risk the safety of people and installations, are protected by the Sepam password. In addition to this protection, the E-LANs and S-LANs must be designed as private networks, protected from external actions by all suitable methods.*

# SFT2841 setting and operating software
## Configuration of a Sepam network




*Configuration window for the communication network via telephone modem.*

### Link via telephone modem

The Sepam units are connected to an RS 485 multidrop network using an industrial PSTN modem.
This modem is the called modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

The PC may use an internal or an external modem. This modem on the PC side is always the calling modem. It must be installed and configured in accordance with the Windows modem installation procedure.

### Configuration of the calling modem in SFT2841

When configuring a Sepam network, SFT2841 displays the list of all the modems installed on the PC:
The communication parameters to be defined are:
- modem: select one of the modems listed by SFT2841
- telephone no.: no. of the remote modem to be called
- speed: 4800, 9600, 19200 or 38400 bauds
- parity: none (not adjustable)
- handshake: none, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.

Communication via modem and telephone network is slowed considerably because of the transit time through the modems. A time-out of between 800 ms and 1000 ms is sufficient in most 38400 baud installations. In some cases, the poor quality of the telephone network may require a slower speed (9600 or 4800 bauds). The time-out value should then be increased (2 to 3 seconds).
- number of retries: from 1 to 6.

***Note:*** *the speed and parity of the calling modem must be configured under Windows with the same values as for SFT2841.*

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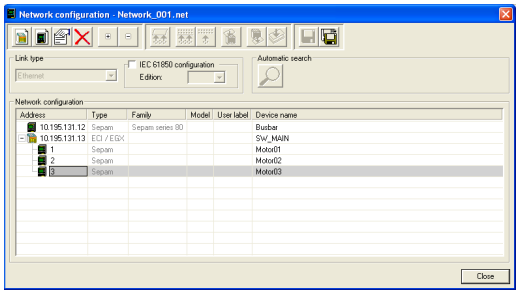



*Configuration window for the communication network via telephone modem.*

## Configuration of called modem

The modem on the Sepam side is the called modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

**Modem RS 485 interface**

In general, the configuration parameters for the modem's RS 485 interface must be defined in accordance with the Sepam communication interface configuration:

- speed: 4800, 9600, 19200 or 38400 bauds
- character format: 8 data bits + 1 stop bit + parity (none, even, odd).

**Telephone network interface**

Modern modems offer sophisticated features such as checking the quality of the telephone line, error correction and data compression. These options are not appropriate for communication between SFT2841 and Sepam, which is based on the Modbus RTU protocol. Their effect on communication performance may be the opposite of the expected result.

It is therefore highly advisable to:

- Invalidate the error correction, data compression and telephone line quality monitoring options
- Use the same end-to-end communication speed between:
  - the Sepam network and the called modem
  - the called modem (Sepam side) and the calling modem (PC side)
  - the PC and the calling modem (see recommended configurations table).

| Sepam network | Telephone network | PC modem interface |
|---|---|---|
| 38400 bauds | V34 modulation, 33600 bauds | 38400 bauds |
| 19200 bauds | V34 modulation, 19200 bauds | 19200 bauds |
| 9600 bauds | V32 modulation, 9600 bauds | 9600 bauds |

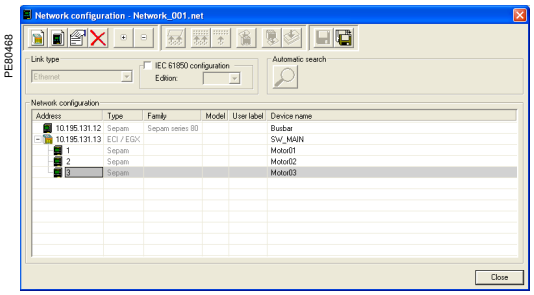
**Industrial configuration profile**

The following table shows the main characteristics of the modem on the Sepam side. These characteristics match a configuration profile commonly known as an "industrial profile", as opposed to the configuration of modems used in offices.

Depending on the type of modem used, the configuration will either be via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

| Characteristics of the "industrial profile" configuration | AT command |
|---|---|
| Transmission in buffered mode, without error correction | \N0 (force &Q6) |
| Data compression deactivated | %C0 |
| Line quality monitoring deactivated | %E0 |
| DTR signal assumed to be permanently off (allows the modem connection to be established automatically on an incoming call) | &D0 |
| CD signal off when carrier is present | &C1 |
| All reports made to Sepam blocked | Q1 |
| Character echo suppression | E0 |
| No flow control | &K0 |

# SFT2841 setting and operating software
## Configuration of a Sepam network



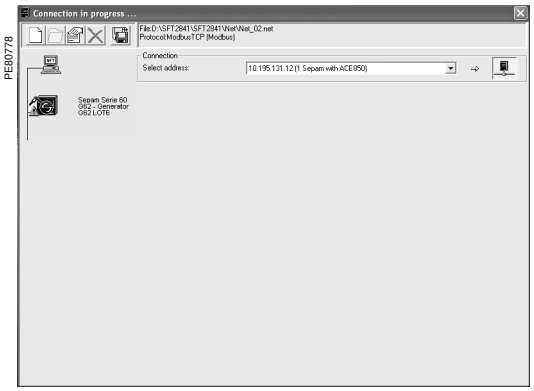

*Sepam network connected to SFT2841.*

### Identification of Sepam units connected to the communication network

The Sepam units connected to the communication network are identified by either.
- their Modbus address
- their IP address
- the IP address for their gateway and their Modbus address

These addresses can be configured in either of the following ways:
- Manually, one by one:
  - the "Add" button is used to define a new device
  - the "Edit" button is used to modify the Modbus address if necessary
  - the "Delete" button removes a device from the configuration
- or automatically for Modbus addresses, by running an automatic search of the Sepam units connected:
  - the "Automatic search"/"Stop search" button starts or interrupts the search
  - when SFT2841 recognizes a Sepam unit, its Modbus address and type are shown on screen
  - when a Modbus device other than Sepam responds to SFT2841, its Modbus address is displayed. The text "???" indicates that the device is not a Sepam.

The Sepam network configuration is saved in a file when the UMI window closes, by pressing the "OK" button.




*Access to parameters and settings for a Sepam series 60 connected to a communication network.*

### Access to Sepam information

To establish communication between SFT2841 and a Sepam network, select the Sepam network configuration you want, select the device connected to the TCP/IP network and press "Connect".
The Sepam network is displayed in the connection window. SFT2841 polls all the equipment defined in the selected configuration. Each Sepam queried is represented by an icon:
- Sepam series 20 or Sepam series 40 actually connected to the network
- Sepam series 60, Sepam series 80 actually connected to the network
- Sepam configured but not connected to the network
- Device other than Sepam connected to the network.

A summary report of each Sepam detected as present is also displayed:
- Sepam Modbus address
- Type of application and Sepam identification
- Any alarms present
- Any minor/major faults present.

To access parameters, settings and operation and maintenance information for a particular Sepam, click on the icon for that Sepam. SFT2841 then establishes a point-to-point connection with the selected Sepam.

### Basic UMI

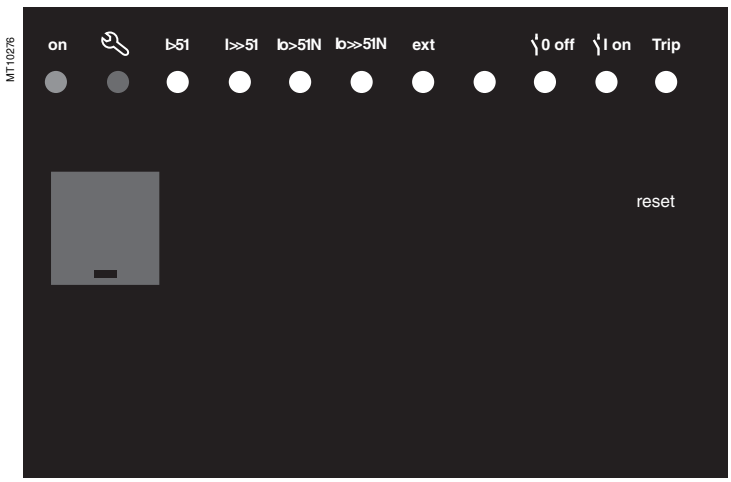
This UMI includes:

■ 2 signal lamps indicating Sepam operating status:
□ green "**on**" indicator: device on
□ red indicator: device unavailable (initialization phase or detection of internal failure)

■ 9 parameterizable yellow signal lamps, fitted with a standard label (with SFT2841, a customized label can be printed on a laser printer)

■ key for clearing faults and resetting

■ 1 connection port for the link with the PC (CCA783 or CCA784 cord), the connector is protected by a sliding cover.




### Fixed or remote advanced UMI

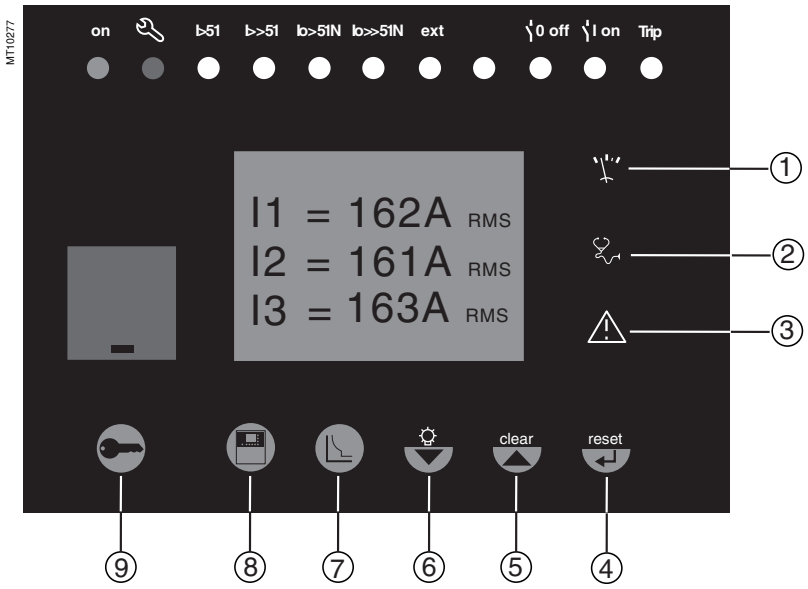
In addition to the basic UMI functions, this version provides:

■ **a "graphic" LCD display** for the display of measurements, parameter/protection settings and alarm and operating messages.
The number of lines, size of characters and symbols are in accordance with the screens and language versions.
The LCD display is back-lit when the user presses a key.

■ **a 9-key keypad with 2 operating modes:**

**White keys for current operation:**
① display of measurements,
② display of "switchgear, network diagnosis" data,
③ display of alarm messages,
④ resetting,
⑤ acknowledgment and clearing of alarms.

**Blue keys activated in parameter and protection setting mode:**
⑦ access to protection settings,
⑧ access to Sepam parameter setting,
⑨ used to enter the 2 passwords required to change protection and parameter settings.
The ↵, ▲, ▼ (④, ⑤, ⑥) keys are used to browse through the menus and to scroll and accept the values displayed.
⑥ **"lamp test" key:**
switching on sequence of all the signal lamps.



## Access to measurements and parameters

The measurements and parameters may be accessed using the metering, diagnosis, status and protection keys. They are arranged in a series of screens as shown in the diagram opposite.

■ the data are split up by category in 4 menus, associated with the following 4 keys:

□ key: measurements
choice: current, voltage, frequency, power energy

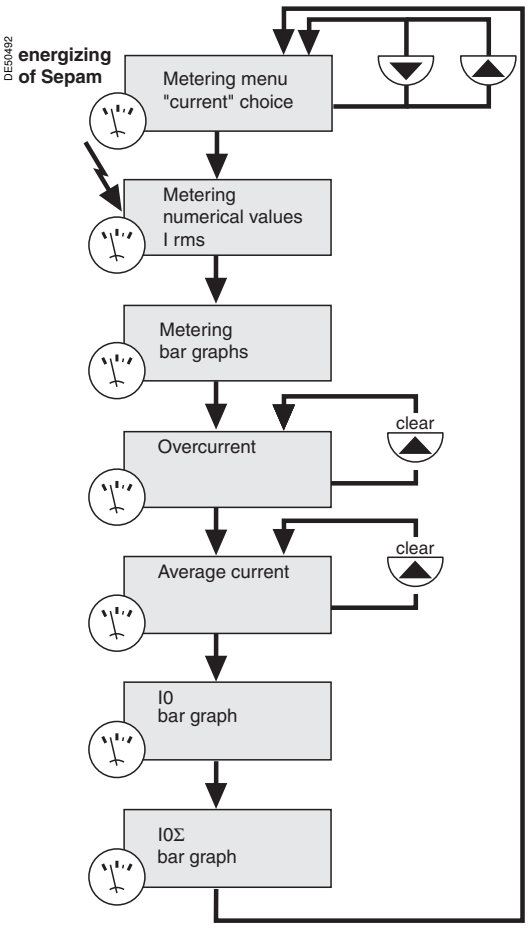
□ key: switchgear diagnosis and additional measurements
choice: diagnosis, tripping contexts (x5)

□ key: general settings
choice: general, modules, I/U sensors, CT/VT supervision, program logic, I/O test

□ key: protection settings
choice: phase I, residual I, directional I, voltage, frequency, power, machine, recloser

■ when the user presses a key, the system moves on to the next screen in the loop. When a screen includes more than 4 lines, the user moves about in the screen via the cursor keys ( , ).

**Example: measurement loop**




## Protection and parameter setting modes

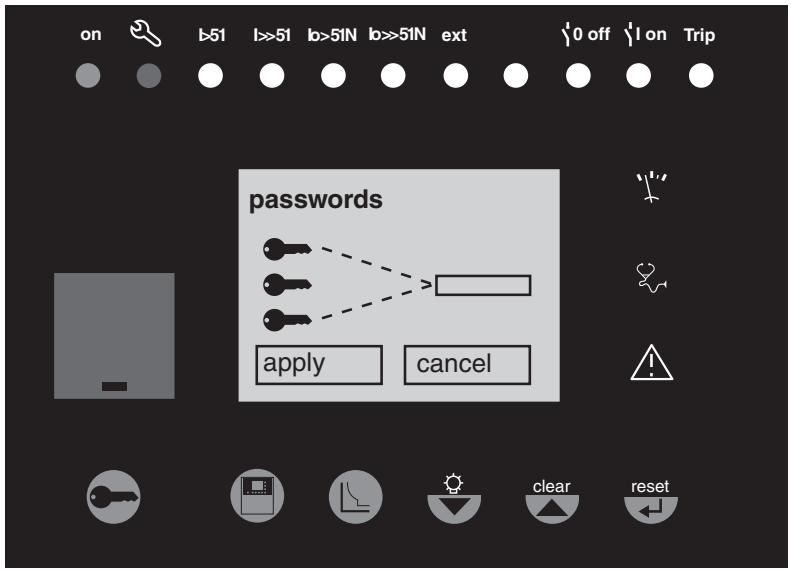
There are 3 levels of use:

■ operator level: used to access all the screens in read mode and does not require any passwords

■ protection setter level: requires the entry of the first password ( key), allows protection setting ( key)

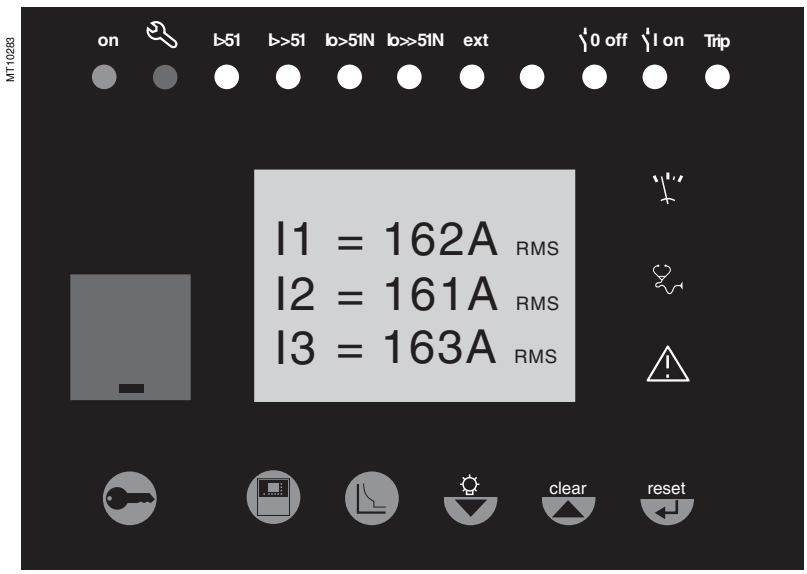
■ parameter setter level: requires the entry of the second password ( key), allows modification of the general settings as well ( key).

Only general setters may modify the passwords.
The passwords have 4 digits.



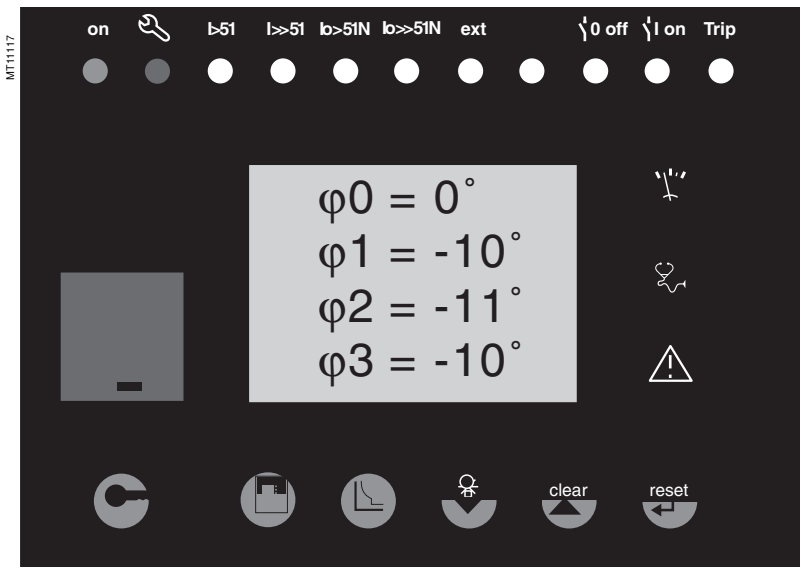
### key

The "metering" key is used to display the variables measured by Sepam.



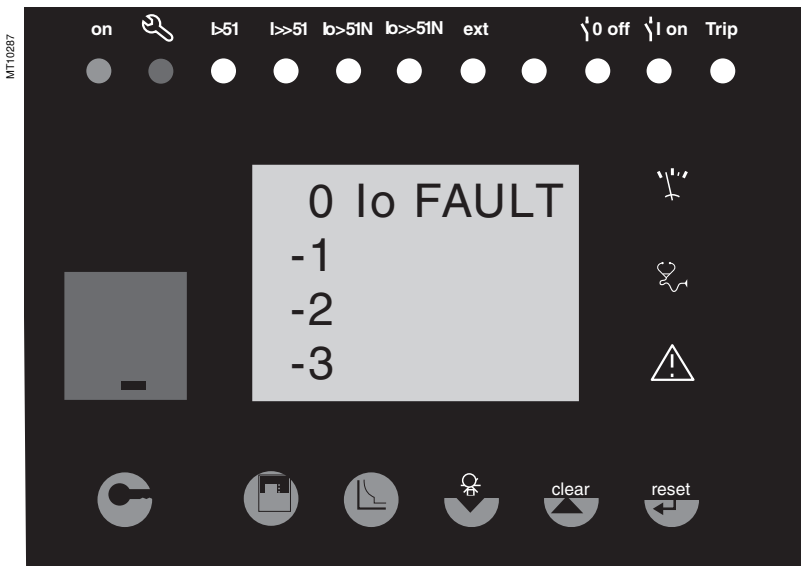

### key

The “diagnosis” key provides access to diagnostic data on the breaking device and additional measurements, to facilitate fault analysis.



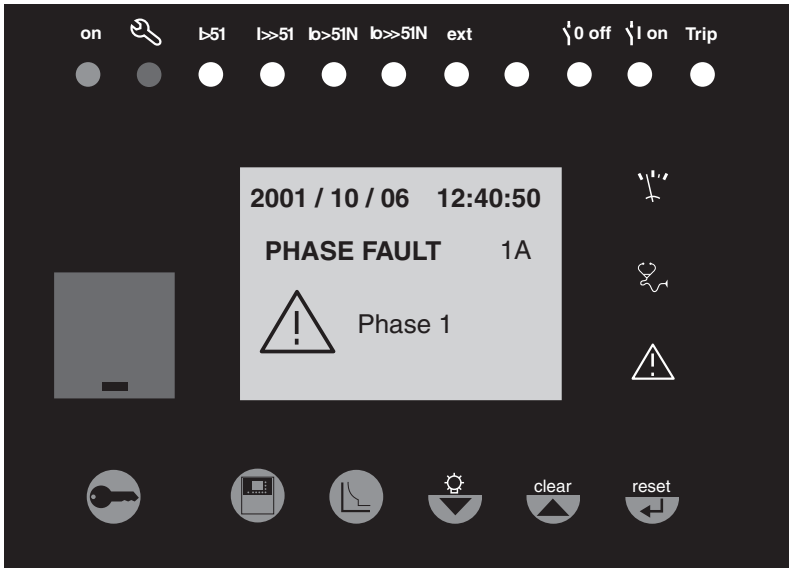

### key

The “alarms” key is used to consult the 16 most recent alarms that have not yet been cleared.



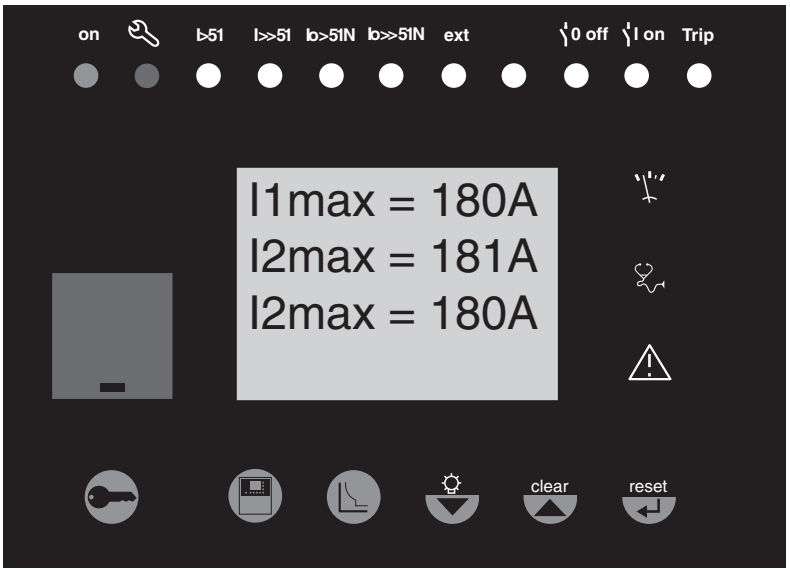
### reset key

The “reset” key resets Sepam (extinction of signal lamps and resetting of protection units after the disappearance of faults).
The alarm messages are not erased.
Sepam resetting must be confirmed.



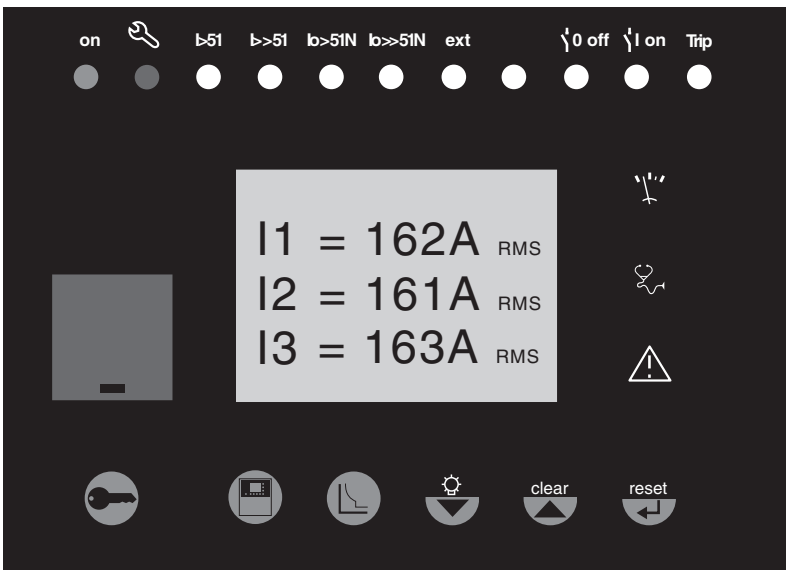

### clear key

When an alarm is present on the Sepam display, the "clear" key is used to return to the screen that was present prior to the appearance of the alarm or to a less recent unacknowledged alarm. Sepam is not reset.
In the metering or diagnosis or alarm menus, the "clear" key may be used to reset the average currents, peak demand currents, running hours counter and alarm stack when they are shown on the display.




### key

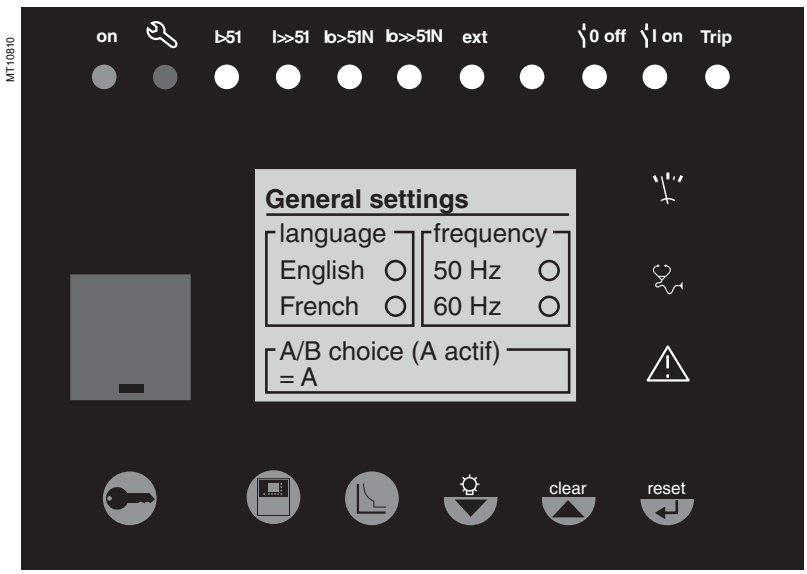
Press the "lamp test" key for 5 seconds to start up a LED and display test sequence.
When an alarm is present, the "lamp test" key is disabled.



# Advanced UMI
## Blue keys for parameter and protection setting

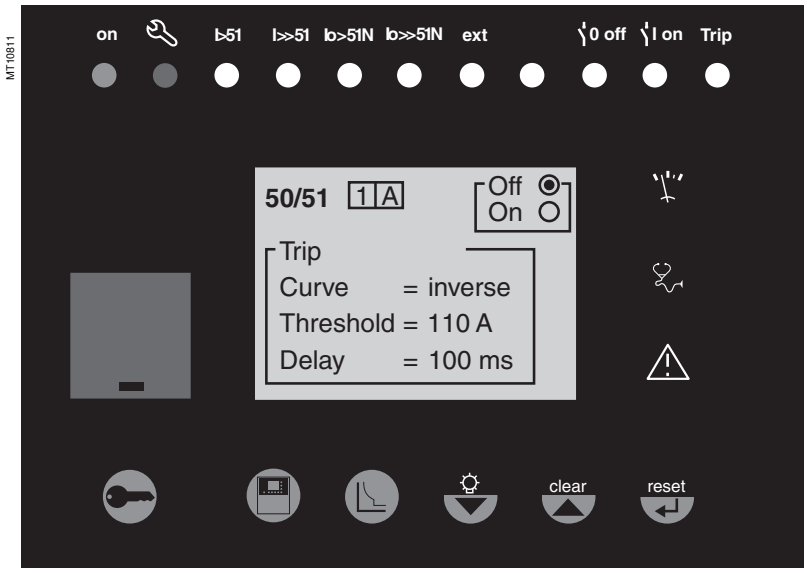
### key

The “status” key is used to display and enter the Sepam general settings. They define the protected equipment characteristics and the different optional modules.
This key can also be used to access the version compatible with SFT2841 screen.




### key

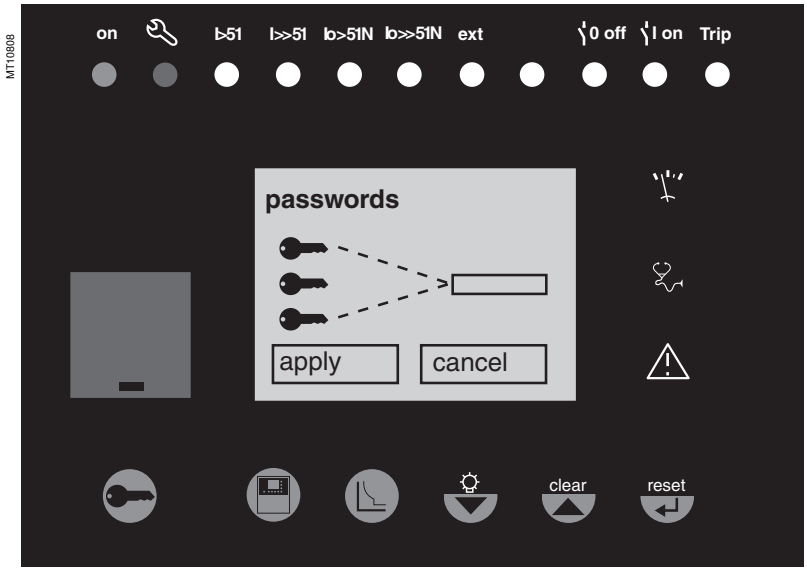
The “protection” key is used to display, set and enable or disable the protection units.




### key

The "wrench" key is used to enter the passwords for access to the different modes:
- protection setting
- parameter setting.

and return to "operating" mode (with no passwords).

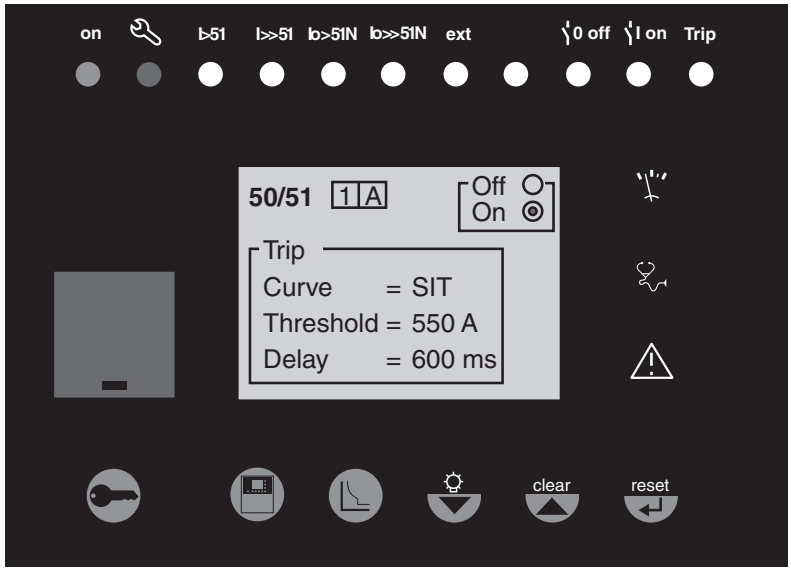



***Note:*** *for parameter setting of signal lamps and output relays, it is necessary to use the SFT2841 software, "program logic" menu.*

# Advanced UMI
## Blue keys for parameter and protection setting

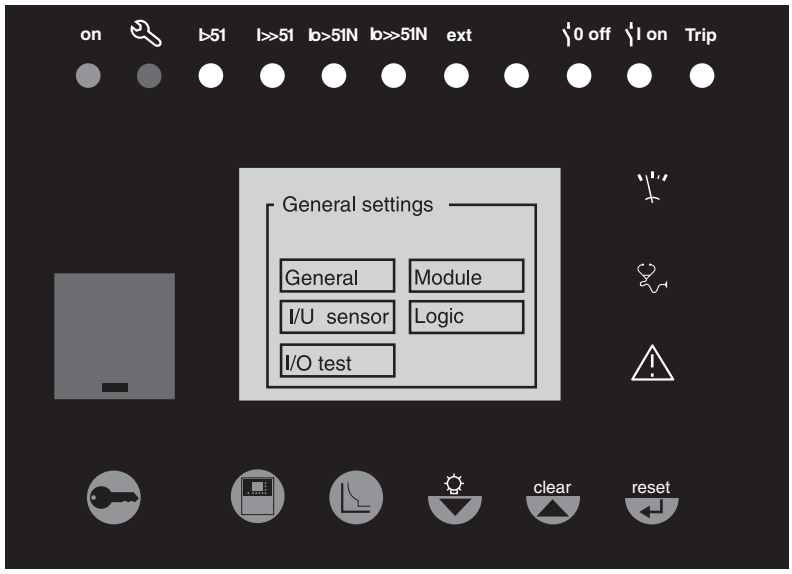
### reset key

The ↵ key is used to confirm the protection settings, parameter settings and passwords.



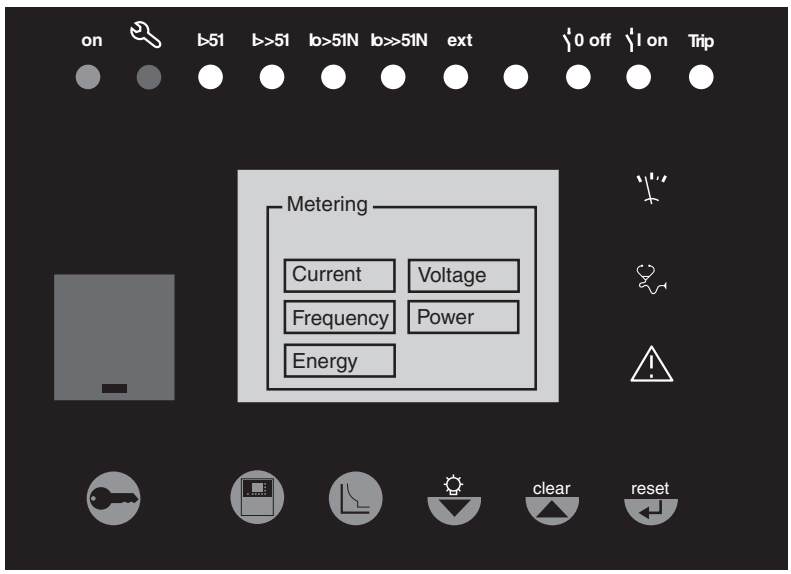

### clear key

When there are no alarms on the Sepam display and the user is in the status, protection or alarm menu, the ▲ key is used to move the cursor upward.




### key

When there are no alarms on the Sepam display and the user is in the status, protection or alarm menu, the ▼ key is used to move the cursor downward.



## Use of passwords

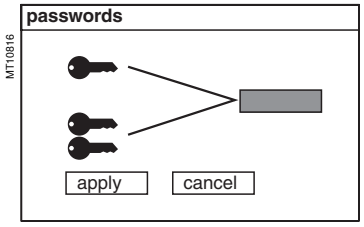
**Sepam** has two 4-digit passwords.

- The first password, symbolized by a key, is used to modify the protection settings
- The second password, symbolized by two keys, is used to modify the protection settings and all the general settings.

**The 2 factory-set passwords are: 0000**

**Entry of passwords**

Press the ↵ key to display the following screen:



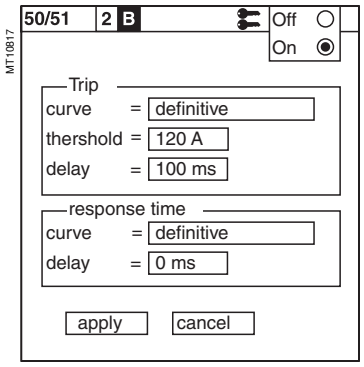

Press the ↵ key to position the cursor on the first digit 0|X|X|X

Scroll through the digits using the cursor keys (▲, ▼) then confirm to go on to the next digit by pressing the ↵ key. Do not use characters other than numbers 0 to 9 for each of the 4 digits.

When the password for your qualification level is entered, press the ▼ key to position the cursor on the apply box. Press the ↵ key again to confirm.

When Sepam is in protection setting mode, a key appears at the top of the display.

When Sepam is in parameter setting mode, two keys appear at the top of the display.




Access to the protection setting or parameter setting modes is disabled:

- By pressing the ↵ key
- Automatically if no keys are activated for more than 5 minutes.

**Modification of passwords**

Only the parameter setting qualification level (2 keys) or the SFT2841 allow modification of the passwords. Passwords are modified in the general settings screen, 💾 key.

**Loss of passwords**

If the factory-set passwords have been modified and the latest passwords entered have been irretrievably lost by the user, please contact your local after-sales service representative.

## Entry of parameters or settings

**Principle applicable to all Sepam screens**

(example of phase overcurrent protection)

- Enter the password
- Access the corresponding screen by successively pressing the 📐 key
- Move the cursor by pressing the ▼ key for access to the desired field (e.g. curve)
- Press the ↵ key to confirm the choice, then select the type of curve by pressing the ▼ or ▲ key and confirm by pressing the ↵ key
- Press the ▼ key to reach the following fields, up to the apply box. Press the ↵ key to confirm the setting.

**Entry of numerical values**

(e.g. current threshold value)

- Position the cursor on the required field using the ▼ ▲ keys, then confirm to go on to the next digit by pressing the ↵ key
- Select the first digit to be entered and set the value by pressing the ▼ or ▲ key (choice of ___: 0……9)
- Press the ↵ key to confirm the choice and go on to the following digit.

The values are entered with 3 significant digits and a period.

The unit (e.g. A or kA) is chosen using the last digit.

- Press the ↵ key to confirm the entry, then press the key for access to the following field
- All of the values entered are only effective after the user confirms by selecting the apply box at the bottom of the screen and presses the ↵ key.

# Default parameters, all applications

### Hardware configuration
- identification: Sepam xxxx
- model: MX
- MES module: absent
- MET modules: absent
- MSA module: absent
- DSM module: present
- ACE module: absent

### Output parameter setting
- outputs used: O1 to O4
- shunt trip units: O1, O3
- undervoltage trip units: O2, O4
- impulse mode: no (latched)

### Program logic
- circuit breaker control: yes
- logic discrimination: no
- recloser: no
- logic input assignment: not used

### General characteristics
- network frequency: 50 Hz
- group of settings: A
- enable remote setting: no
- working language: English
- type of cubicle: feeder (except G40: incomer)
- CT rating: 5 A
- number of CTs: 3 (I1, I2, I3)
- rated current In: 630 A
- basic current Ib: 630 A
- integration period: 5 mn
- residual current: none
- rated primary voltage (Unp): 20 kV
- rated secondary voltage (Uns): 100 V
- voltages measured by VTs: U21, U32
- residual voltage: none
- disturbance recording: 9 x 2-second blocks
- pre-trig for disturbance recording: 36 periods.

### Protection functions
- all the protections are "off"
- the settings comprise values and choices that are informative and consistent with the general characteristics by default (in particular rated current and voltage In and Un)
- tripping behavior:
  - latching: 50/51, 50V/51V, 50N/51N, 67, 67N, 46, 46BC, 32P, 32Q/40, 48/51LR/14, 27D, 38/49T, 49RMS
  - participation in circuit breaker control: 50/51, 50V/51V, 50N/51N, 67, 67N, 46, 46BC, 32P, 32Q/40, 48/51LR/14, 27D, 49RMS, 38/49T, 37
  - disturbance recording triggering: with.

### Control matrix
- activation of signal lamps according to front panel markings
- watchdog on output O4
- disturbance recording triggering upon activation of pick up signal.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should commission this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Obey all existing safety instructions when commissioning and maintaining high-voltage equipment.
- Beware of potential hazards and wear personal protective equipment.

**Failure to follow these instructions will result in death or serious injury.**

## Protection relay testing

Protection relays are tested prior to commissioning, with the dual aim of maximizing availability and minimizing the risk of malfunctioning of the assembly being commissioned. The problem consists of defining the consistency of the appropriate tests, keeping in mind that the relay is always involved as the main link in the protection chain.

Therefore, protection relays based on electromechanical and static technologies, the performances of which are not totally reproducible, must be systematically submitted to detailed testing, not only to qualify relay commissioning, but also to check that they actually are in good operating order and maintain the required level of performance.

**The Sepam concept makes it possible to do away with such testing, since:**

- the use of digital technology guarantees the reproducibility of the performances announced
- each of the Sepam functions has undergone full factory-qualification
- an internal self-testing system provides continuous information on the state of the electronic components and the integrity of the functions (e.g. automatic tests diagnose the level of component polarization voltages, the continuity of the analog value acquisition chain, non-alteration of RAM memory, absence of settings outside the tolerance range) and thereby guarantees a high level of availability

**Sepam is therefore ready to operate without requiring any additional qualification testing that concerns it directly.**

## Sepam commissioning tests

The preliminary Sepam commissining tests may be limited to a commissioning check, i.e.:

- checking of compliance with BOMs and hardware installation diagrams and rules during a preliminary general check
- checking of the compliance of the general settings and protection settings entered with the setting sheets
- checking of current or voltage input connection by secondary injection tests
- checking of logic input and output connection by simulation of input data and forcing of output status
- validation of the complete protection chain (possible customized logic functions included)
- checking of the connection of the optional MET148-2 and MSA141 modules.

The various checks are described further on.

## General principles

- **all the tests should be carried out with the MV cubicle completely isolated and the MV circuit breaker racked out (disconnected and open)**
- **all the tests are to be performed in the operating situation: no wiring or setting changes, even temporary changes to facilitate testing, are allowed.**
- the SFT2841 parameter setting and operating software is the basic tool for all Sepam users. It is especially useful during Sepam commissioning tests. The tests described in this document are systematically based on the use of that tool.

## Method

For each Sepam:

- only carry out the checks suited to the hardware configuration and the functions activated

(A comprehensive description of all the tests is given further on)

- use the test sheet provided to record the results of the commissioning tests.

**Checking of current and voltage input connections**

The secondary injection tests to be carried out to check the connection of the current and voltage inputs are described according to:

- the type of current and voltage sensors connected to Sepam, in particular for residual current and voltage measurement
- the type of injection generator used for the tests: three-phase or single-phase generator.

The different possible tests are described further on by:

- a detailed test procedure
- the connection diagram of the associated test generator.

The table below specifies the tests to be carried out according to the type of measurement sensors and type of generator used, and indicates the page on which each test is described.

| **Current sensors** | **3 CTs** | **3 CTs + 1 core balance CT** | **3 CTs** | **3 CTs + 1 core balance CT** |
|---|---|---|---|---|
| **Voltage sensors** | **3 VTs** | **3 VTs** | **2 phase VTs + 1 residual VT** | **2 phase VTs + 1 residual VT** |
| Three-phase generator | Page 290 | Page 290<br>Page 295 | Page 291<br>Page 296 | Page 291<br>Page 297 |
| Single-phase generator | Page 292 | Page 292<br>Page 295 | Page 292<br>Page 296 | Page 292<br>Page 297 |

# Testing and metering equipment required

### Generators

- dual sinusoidal AC current and voltage generator:
  - 50 or 60 Hz frequency (according to the country)
  - current adjustable up to at least 5 Arms
  - adjustable up to the rated secondary phase-to-phase voltage of the VTs
  - adjustable relative phase displacement (V, I)
  - three-phase or single-phase type
- DC voltage generator:
  - adjustable from 48 to 250 V DC, for adaptation to the voltage level of the logic input being tested.

### Accessories

- plug with cord to match the "current" test terminal box installed
- plug with cord to match the "voltage" test terminal box installed
- electric cord with clamps, wire grip or touch probes.

### Metering devices (built into the generator or separate)

- 1 ammeter, 0 to 5 A rms
- 1 voltmeter, 0 to 230 V rms
- 1 phasemeter (if phase displacement (V, I) is not identified on the voltage and current generator).

### Computer equipment

- PC with minimal configuration:
  - Microsoft Windows XP or Vista
  - 400 MHz Pentium processor,
  - 64 MB of RAM
  - 200 MB free on hard disk
  - CD-ROM drive
- SFT2841 software
- CCA783 serial connection or CCA784 USB cord between the PC and Sepam.

### Documents

- complete connection diagram of Sepam and additional modules, with:
  - phase current input connection to the corresponding CTs via the test terminal box
  - residual current input connection
  - phase voltage input connection to the corresponding VTs via the test terminal box
  - residual voltage input connection to the corresponding VTs via the test terminal box
  - logic input and output connection
  - temperature sensor connection
  - analog output connection
- hardware BOMs and installation rules
- group of Sepam parameter and protection settings, available in paper format.

# General examination and preliminary actions

## Checking to be done prior to energizing

Apart from the mechanical state of the equipment, use the diagrams and BOMs provided by the contractor to check:

- identification of Sepam and accessories determined by the contractor
- correct earthing of Sepam (via terminal 17 of the 20-pin connector)
- correct connection of auxiliary voltage (terminal 1: AC or positive polarity; terminal 2: AC or negative polarity)
- presence of a residual current measurement core balance CT and/or additional modules connected to Sepam, when applicable
- presence of test terminal boxes upstream from the current inputs and voltage inputs
- conformity of connections between Sepam terminals and the test terminal boxes.

## Connections

Check that the connections are tightened (with equipment non-energized).
The Sepam connectors must be correctly plugged in and locked.

## Energizing

1. Switch on the auxiliary power supply.
2. Check that Sepam performs the following initialization sequence, which lasts approximately 6 seconds:
   - green ON and red indicators on
   - red indicator off
   - pick-up of "watchdog" contact.

The first screen displayed is the phase current measurement screen.

## Implementation of the SFT2841 software for PC

1. Start up the PC.
2. Connect the PC RS232 serial or USB port to the communication port on the front panel of Sepam using the CCA783 or CCA784 cord.
3. Start up the SFT2841 software, by clicking on the related icon.
4. Choose to connect to the Sepam to be checked.

## Identification of Sepam

1. Note the Sepam serial number given on the label stuck to the right side plate of the base unit
2. Note the Sepam type and software version using the SFT2841 software, "Sepam Diagnosis" screen
3. Enter them in the test sheet.

# Checking of parameter and protection settings

## Determination of parameter and protection settings

All of the Sepam parameter and protection settings are determined beforehand by the design department in charge of the application, and should be approved by the customer.
It is presumed that the study has been carried out with all the attention necessary, or even consolidated by a network coordination study.
All of the Sepam parameter and protection settings should be available at the time of commissioning:
- in hard copy format (with the SFT2841 software, the parameter and protection setting file for a Sepam can be printed directly or exported to a text file for editing)
- and, when applicable, in the format of a file to be downloaded into Sepam using the SFT2841 software.

## Checking parameters and protection settings

Check to be made when the Sepam parameter and protection settings have not been entered or downloaded during commissioning testing, to confirm the conformity of the parameter and protection settings entered with the values determined during the study.
The aim of this check is not to confirm the relevance of the parameter and protection settings.
1. Go through all the parameter and protection setting screens in the SFT2841 software, in the order proposed in guided mode.
2. For each screen, compare the values entered in the Sepam with the values recorded in the parameter and protection setting file.
3. Correct any parameter and protection settings that have not been entered correctly, proceeding as indicated in the "Use of the (SFT2841) software" section of this manual.

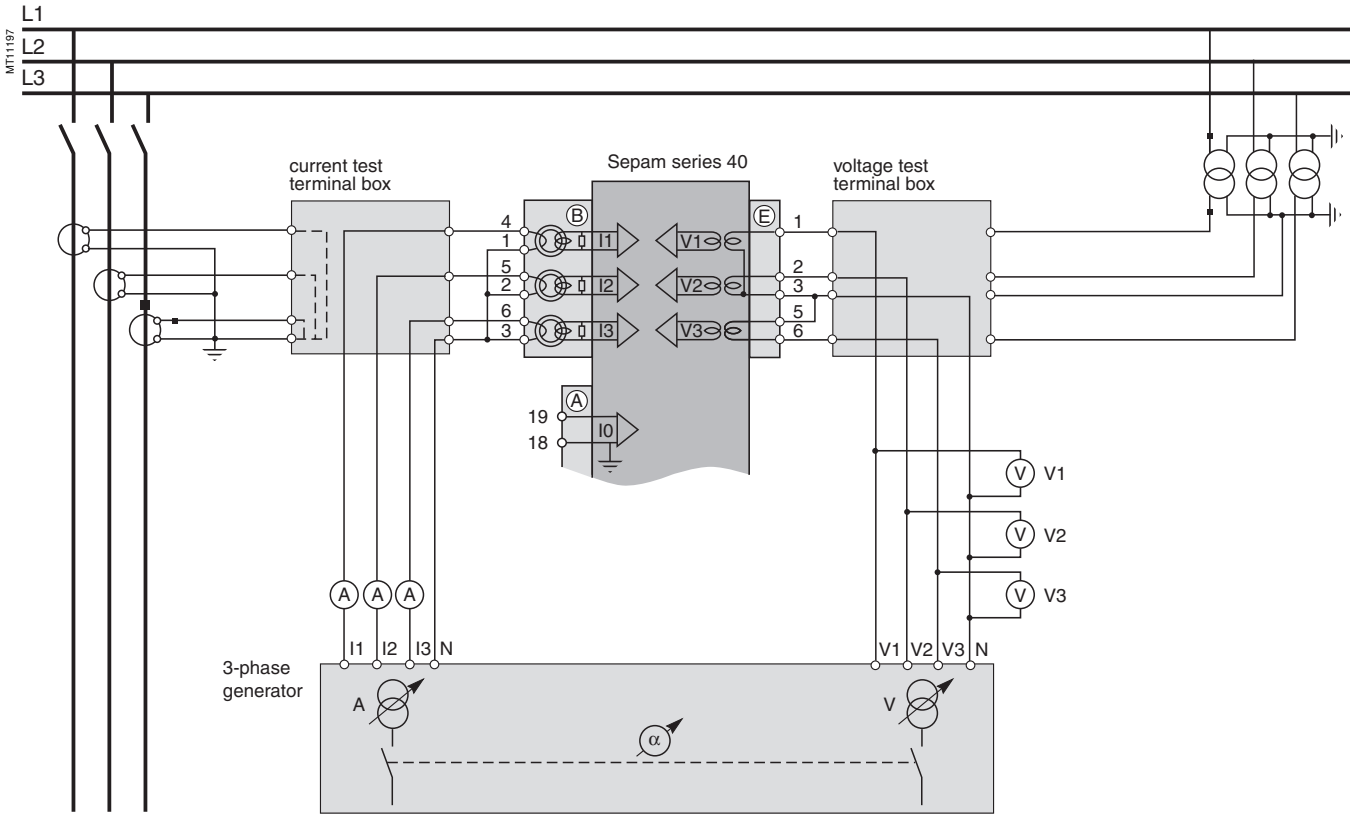
## Conclusion

Once the checking has been done and proven to be conclusive, as of that phase, the parameter and protection settings should not be changed any further and are considered to be final.
In order to be conclusive, the tests which follow must be performed with these parameter and protection settings. We strongly recommend that you do not modify, even temporarily, any of the existing values to facilitate testing.

# Checking of phase current and voltage input connection
## With 3-phase generator

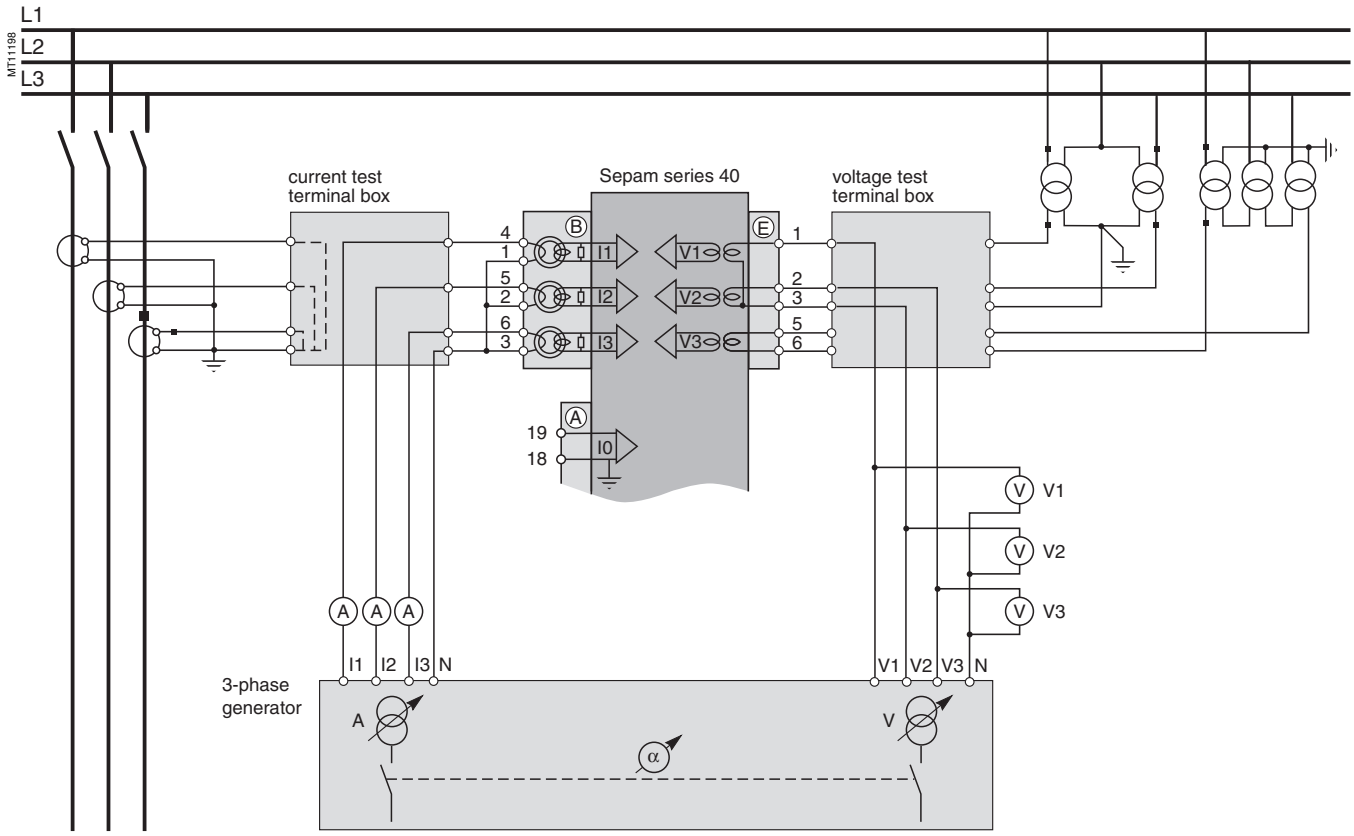
### Procedure

1. Connect the 3-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the appropriate diagram in terms of the number of VTs connected to Sepam:
   - block diagram with 3 VTs connected to Sepam



# Checking of phase current and voltage input connection
## With 3-phase generator

■ block diagram with 2 VTs connected to Sepam.

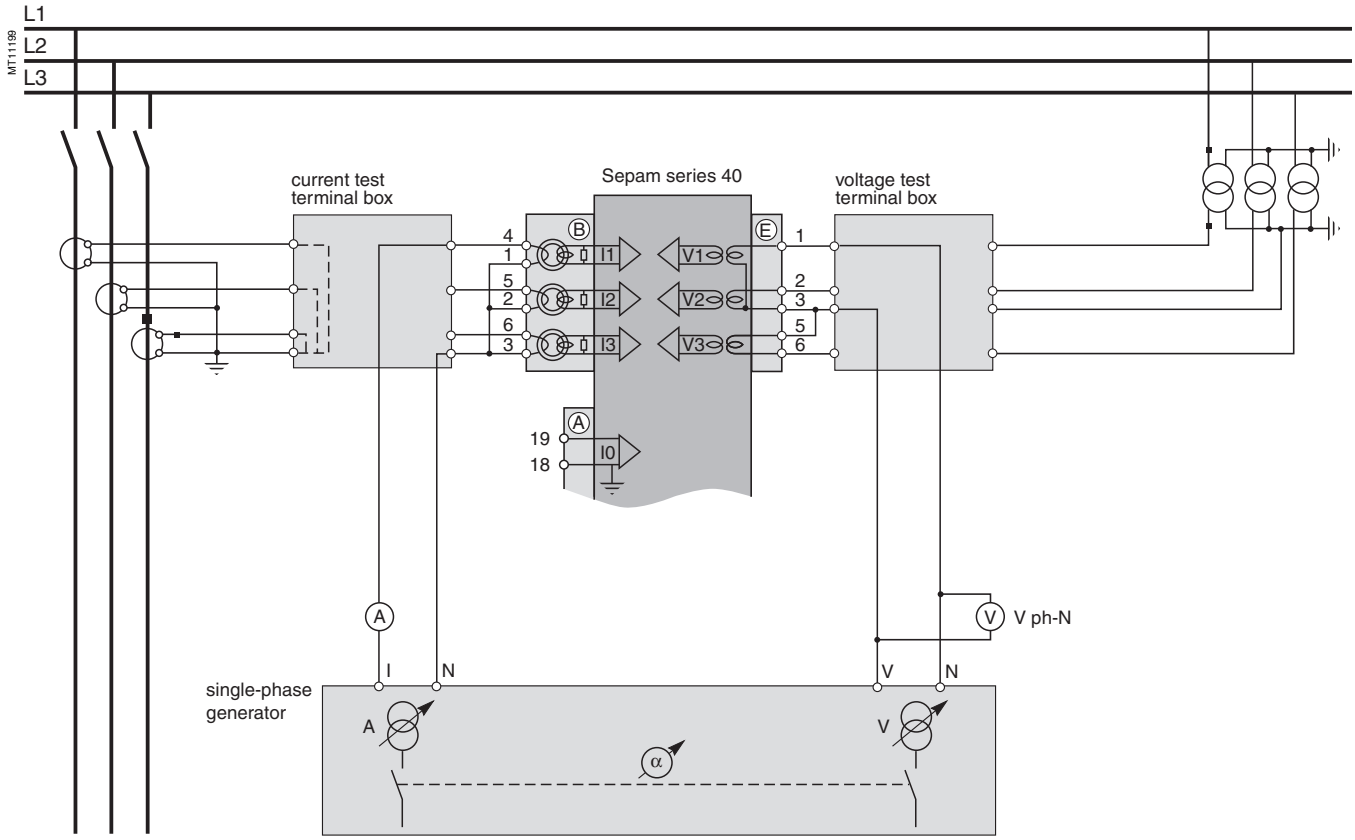



2. Turn the generator on.
3. Apply the 3 generator voltages V1-N, V2-N and V3-N, balanced and set to the rated secondary phase-to-neutral voltage of the VTs (i.e. Vns = Uns/$\sqrt{3}$).
4. Inject the 3 generator currents I1, I2 and I3, balanced and set to the rated secondary current of the CTs (i.e. 1 A or 5 A) and in phase with the voltages applied (i.e. generator phase displacement:
$\alpha$1(V1-N, I1) = $\alpha$2(V2-N, I2) = $\alpha$3(V3-N, I3) = 0°).
5. Use the SFT2841 software to check the following:
■ the value indicated for each of the phase currents I1, I2 and I3 is approximately equal to the rated primary current of the CTs
■ the value indicated for each of the phase-to-neutral voltages V1, V2 and V3 is approximately equal to the rated primary phase-to-neutral voltage of the VT (Vnp = Unp/$\sqrt{3}$)
■ the value indicated for each phase displacement $\varphi$1(V1, I1), $\varphi$2(V2, I2) and $\varphi$3(V3, I3) between currents I1, I2 or I3 and voltages V1, V2 or V3 respectively is approximately equal to 0°.
6. Turn the generator off.

# Checking of phase current and voltage input connection
## With single-phase generator and voltages delivered by 3 VTs

### Procedure

1. Connect the single-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the block diagram below:




2. Turn the generator on.
3. Apply the generator V-N voltage set to the rated secondary phase-to-neutral voltage of the VTs (i.e. Vns = Uns/$\sqrt{3}$) between Sepam's phase 1 voltage input terminals (via the test box).
4. Inject the generator I current, set to the rated secondary current of the CTs (i.e. 1 A or 5 A) and in phase with the V-N voltage applied (i.e. generator phase displacement $\alpha$(V-N, I) = 0°) to Sepam's phase 1 current input (via the text box).
5. Use the SFT2841 software to check the following:
■ the value indicated for I1 phase current is approximately equal to the rated primary current of the CT
■ the value indicated for V1 phase-to-neutral voltage is approximately equal to the rated primary phase-to-neutral voltage of the VT (Vnp = Unp/$\sqrt{3}$)
■ the value indicated for the phase displacement $\varphi$1(V1, I1) between the I1 current and V1 voltage is approximately equal to 0°.
6. Proceed in the same way by circular permutation with the phase 2 and 3 voltages and currents, to check the I2, V2, $\varphi$2(V2, I2) and I3, V3, $\varphi$3(V3, I3) values.
7. Turn the generator off.

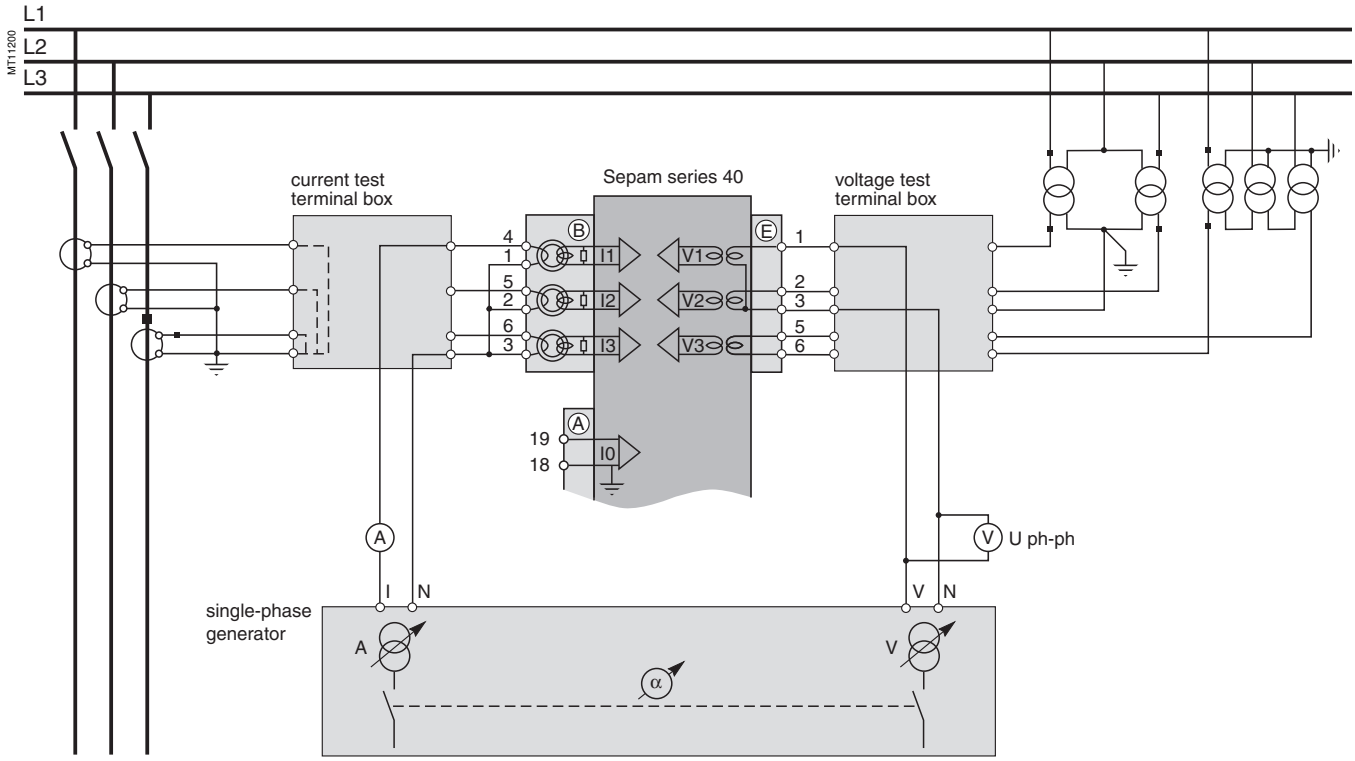
# Checking of phase current and voltage input connection
## With single-phase generator and voltages delivered by 2 VTs

### Description

Check to be carried out when the voltages are supplied by a 2 VT assembly, with the VT primary circuits connected between phases of the distributed voltage, which means that the residual voltage is obtained outside Sepam (by 3 VTs connected via their secondary circuits in an open delta arrangement) or, when applicable, is not used for the protection function.

### Procedure

1. Connect the single-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the block diagram below:




2. Turn the generator on.
3. Apply (via the test box) the voltage delivered at the V-N terminals of the generator, set to $\sqrt{3}/2$ times the rated secondary phase-to-phase voltage of the VTs (i.e. $\sqrt{3}$ Uns/2) between terminals 1-3 of Sepam's voltage inputs.
4. Inject the generator I current, set to the rated secondary current of the CTs (i.e. 1 A or 5 A) and in phase with the V-N voltage applied (i.e. generator phase displacement $\alpha$(V-N, I) = 0°) to Sepam's phase 1 current input (via the test box).
5. Use the SFT2841 software to check the following:
■ the value indicated for I1 phase current is approximately equal to the rated primary current of the CT (Inp)
■ the value indicated for V1 phase-to-neutral voltage is approximately equal to the rated primary phase-to-neutral voltage of the VT (Vnp = Unp/$\sqrt{3}$)
■ the value indicated for the phase displacement $\varphi$1(V1, I1) between the I1 current and V1 voltage is approximately equal to 0°.
6. Proceed in the same way to check the I2, V2, $\varphi$2(V2, I2) values:
■ apply the generator V-N voltage set to $\sqrt{3}$ Uns/2 in parallel between terminals 1-3 and 2-3 of Sepam's voltage inputs (via the test box)
■ inject an I current set to 1 A or 5 A and in phase opposition with the V-N voltage (i.e. $\alpha$(V-N, I) = 180°) to Sepam's phase 2 current input (via the test box)
■ obtain I2 ≅ Inp, V2 ≅ Vnp = Unp/$\sqrt{3}$ and $\varphi$2 ≅ 0°.
7. Check the I3, V3, $\varphi$3(V3, I3) values as well:
■ apply the generator V-N voltage set to $\sqrt{3}$ Uns/2 between terminals 2-3 of Sepam's voltage inputs (via the test box)
■ inject a current equal to 1 A or 5 A and in phase with the V-N voltage (i.e. $\alpha$(V-N, I) = 0°) to Sepam's phase 3 current input (via the test box)
■ obtain I3 ≅ Inp, V3 ≅ Vnp = Unp/$\sqrt{3}$ and $\varphi$3 ≅ 0°.
8. Turn the generator off.

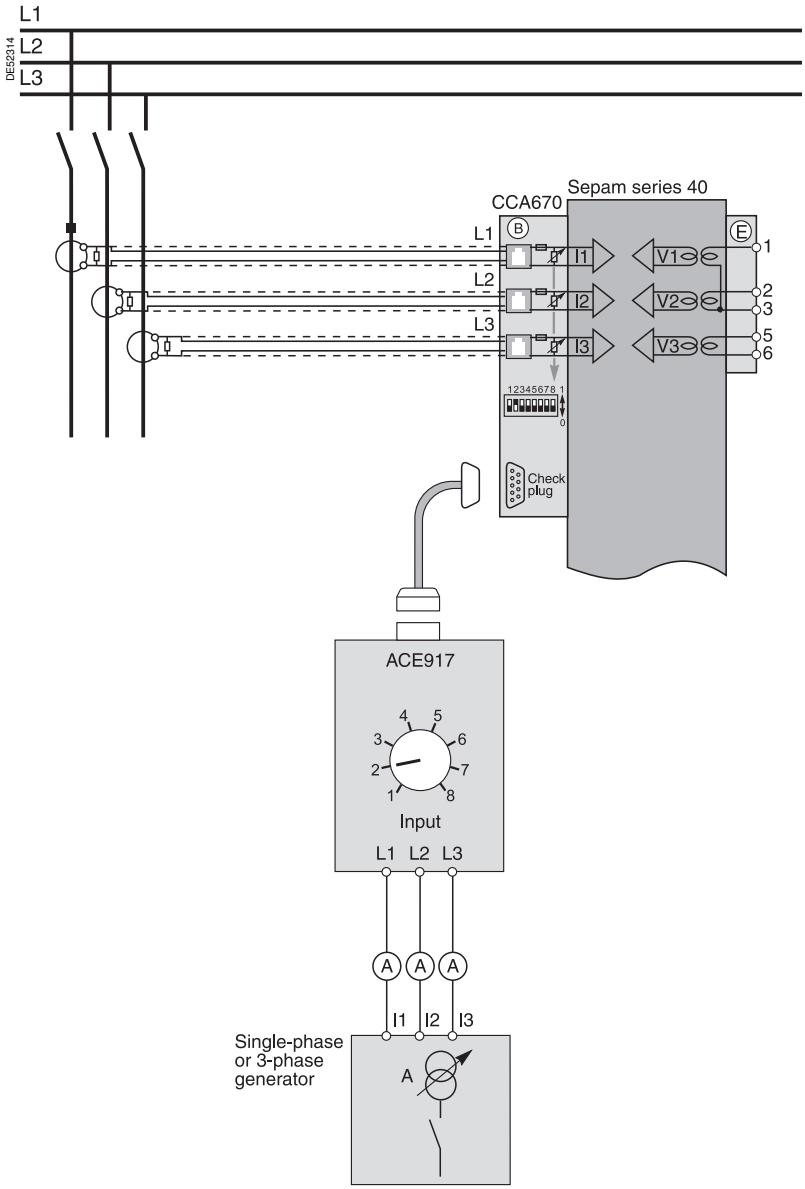
# Checking of phase current and voltage input connection
## LPCT type current sensors

### Description
Check to be performed when phase currents are measured by LPCT-type current sensors.

### Phase current measurement by LPCT sensors
■ The 3 LPCT current sensors are connected via an RJ45 plug to the CCA670 connector which is to be mounted on the rear panel of Sepam, identified as (B)
■ The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into the fail-safe position
■ The rated primary current In measured by the LPCT sensors is to be entered as a Sepam general setting and configured by microswitches on the CCA670 connector.

### Procedure
**The tests to be carried out to check phase current input connections are the same whether the phase currents are measured by CTs or LPCT sensors. Only the Sepam current input connection procedure and current injection values change.**
To test current inputs connected to LPCT sensors with a standard injection box, the ACE917 injection adapter is required.
The ACE917 adapter is inserted between:
■ the standard injection box
■ the LPCT test plug:
□ integrated in the Sepam CCA670 connector
□ or transferred by means of the CCA613 accessory.
The ACE917 injection adapter should be set according to the currents selected on the CCA670 connector: the ACE917 setting should be equal to the number of the microswitch that is set to 1 on the CCA670.
The injection value depends on the rated primary current selected on the CCA670 connector and entered in the Sepam general settings, i.e.:
■ 1 A for the following values (in Amps): 25, 50, 100, 133, 200, 320, 400, 630
■ 5 A for the following values (in Amps): 125, 250, 500, 666, 1000, 1600, 2000, 3150.

### Block diagram (without CCA613 accessory)



# Checking of phase current and voltage input connection

## Description

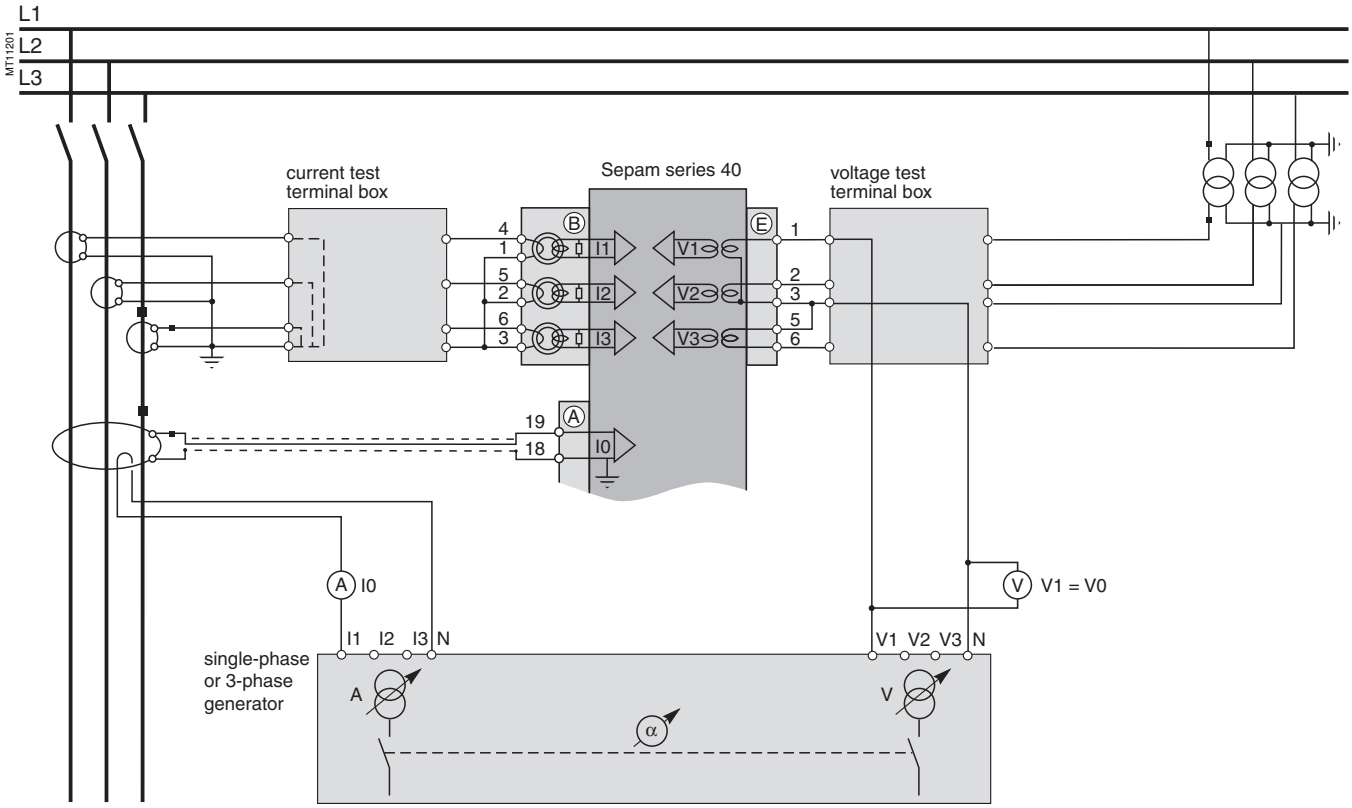
Check to be carried out when the residual current is measured by a specific sensor such as:

- CSH120 or CSH200 core balance CT
- CSH30 interposing ring CT (whether it is installed on the secondary circuit of a single 1 A or 5 A CT which encompasses the 3 phases, or on the neutral connection of the three 1 A or 5 A phase CTs)
- other core balance CT connected to an ACE990 interface,

and when the residual voltage is calculated in Sepam or cannot be calculated (and is therefore not available for the protection function).

## Procedure

1. Connect according to the diagram below:
   - a wire between the generator current terminals to inject current into the primary circuit of the core balance CT or CT, with the wire passing through the core balance CT or CT in the P1-P2 direction, with P1 the busbar end and P2 the cable end
   - when applicable, the generator voltage terminals to the voltage test terminal box, so as to only supply Sepam's phase 1 voltage input and therefore obtain a residual voltage V0 = V1.




2. Turn the generator on.
3. When applicable, apply a V-N voltage set to the rated secondary phase-to-neutral voltage of the VT (i.e. Vns = Uns/$\sqrt{3}$).
4. Inject an I current set to 5 A, and when applicable in phase with the V-N voltage applied (i.e. generator phase displacement $\alpha$(V-N, I) = 0°).
5. Use the SFT2841 software to check the following:
   - the value indicated for the measured I0 residual current is approximately equal to 5 A
   - when applicable, the value indicated for calculated V0 residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs (i.e. Vnp = Unp/$\sqrt{3}$)
   - when applicable, the value indicated for the phase displacement $\varphi$0(V0, I0) between the I0 current and V0 voltage is approximately equal to 0°.
6. Turn the generator off.

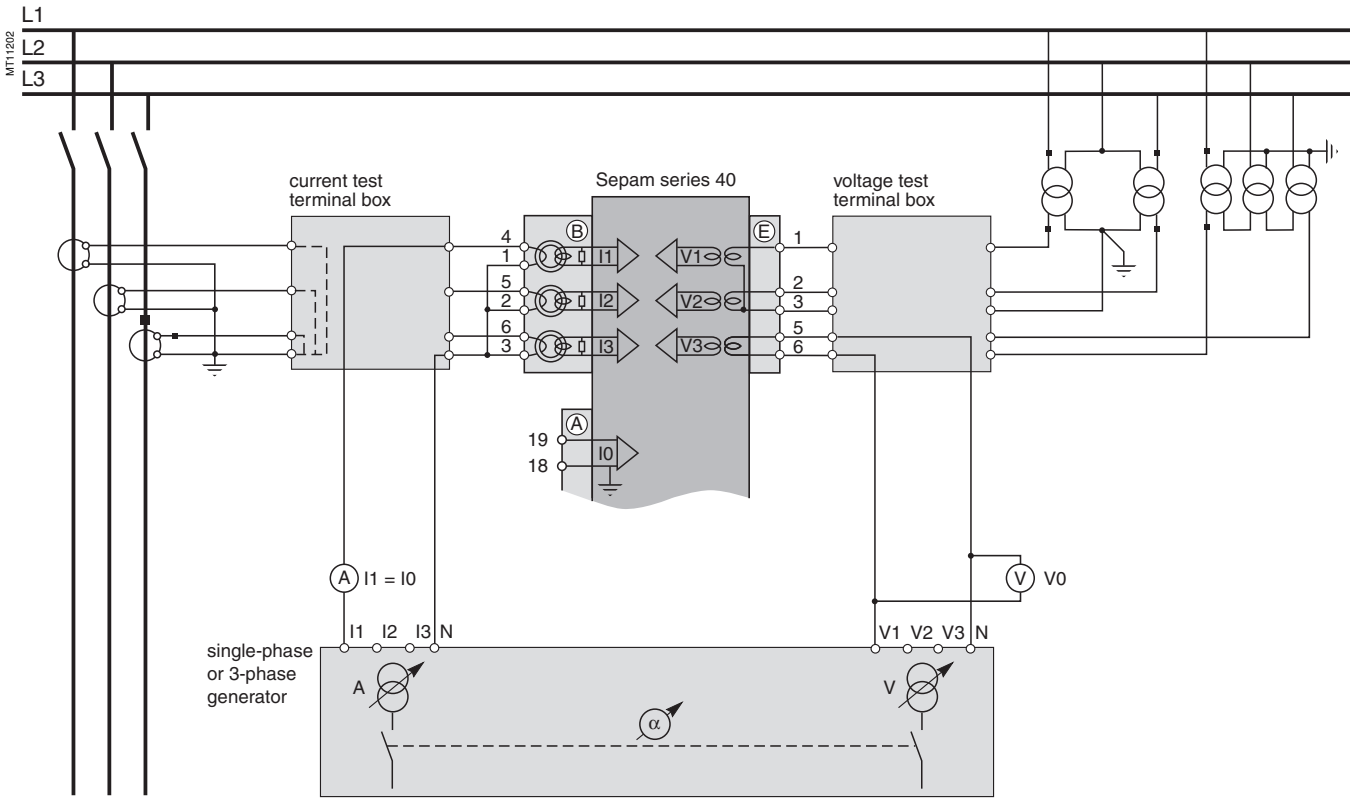
# Checking of residual voltage input connection

## Description

Check to be carried out when the residual voltage is delivered by 3 VTs on the secondary circuits connected in an open delta assembly, and when the residual current is calculated in Sepam or, when applicable, is not used for the protection function.

## Procedure

1. Connect according to the diagram below:
■ the generator voltage terminals to the voltage test terminal box, so as to only supply Sepam's residual voltage input
■ when applicable, the generator current terminals to the current test terminal box, so as to only supply Sepam's phase 1 current input, and therefore obtain a residual current I0Σ = I1.




2. Turn the generator on.
3. Apply a V-N voltage set to the rated secondary voltage of the VTs installed in an open delta arrangement (i.e., depending on the case, Uns/$\sqrt{3}$ or Uns/3).
4. When applicable, inject an I current set to the rated secondary current of the CTs (i.e. 1 A or 5 A) and in phase with the voltage applied (i.e. generator phase displacement $\alpha$(V-N, I) = 0°).
5. Use the SFT2841 software to check the following:
■ the value indicated for the measured V0 residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs (i.e. Vnp = Unp/$\sqrt{3}$)
■ when applicable, the value indicated for the calculated I0Σ residual current is approximately equal to the rated primary current of the CTs
■ when applicable, the value indicated for the phase displacement φ0Σ (V0, I0Σ) between the I0Σ current and V0 voltage is approximately equal to 0°.
6. Turn the generator off.

# Checking of residual current and residual voltage input connection

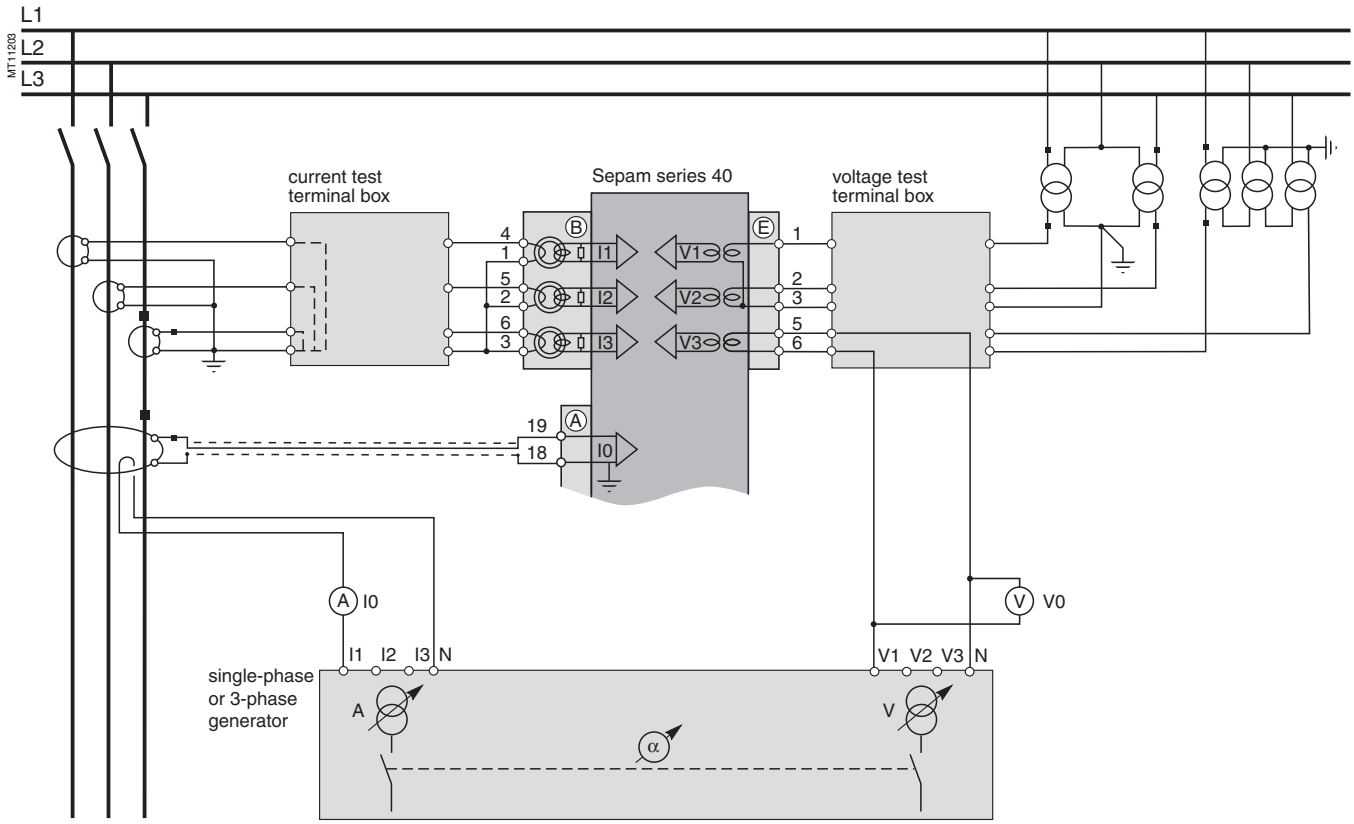
## Description

Check to be carried out when the residual voltage is delivered by 3 VTs on the secondary circuits connected in an open delta assembly and when the residual current is obtained by a specific sensor such as:

- CSH120 or CSH200 core balance CT
- CSH30 interposing ring CT (whether it is installed on the secondary circuit of a single 1 A or 5 A CT which encompasses the 3 phases, or on the neutral connection of the three 1 A or 5 A phase CTs)
- other core balance CT connected to an ACE990 interface.

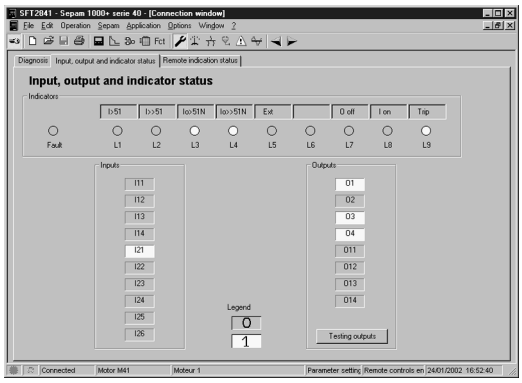
## Procedure

1. Connect according to the diagram below:
   - the generator voltage terminals to the voltage test terminal box using the plug provided,
   - a wire between the generator current terminals to inject current into the primary circuit of the core balance CT or CT, with the wire passing through the core balance CT or CT in the P1-P2 direction, with P1 the busbar end and P2 the cable end.




2. Turn the generator on.
3. Apply a V-N voltage set to the rated secondary voltage of the VTs connected in an open delta arrangement (i.e. Uns/$\sqrt{3}$ or Uns/3).
4. Inject an I current set to 5 A, and in phase with the voltage applied (i.e. generator phase displacement $\alpha$(V-N, I) = 0°).
5. Use the SFT2841 software to check the following:
   - the value indicated for the measured I0 residual current is approximately equal to 5 A
   - the value indicated for the measured V0 residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs (i.e. Vnp = Unp/$\sqrt{3}$ )
   - the value indicated for the phase displacement $\varphi$0(V0, I0) between the I0 current and V0 voltage is approximatelyequal to 0°.
6. Turn the generator off.

# Checking of logic input and output connection


MT11194
SFT2841 - Sepam 1000+ serie 40 - [Connection window]
File Edit Operation Sepam Application Options Window ?
Diagnosis | Input, output and indicator status | Remote indication status
Input, output and indicator status
Indicators
I>51 I>>51 Io>51N Io>>51N Ext 0 off I on Trip
Fault L1 L2 L3 L4 L5 L6 L7 L8 L9
Inputs
I11 I12 I13 I14 I21 I22 I23 I24 I25 I26
Outputs
O1 O2 O3 O4 O11 O12 O13 O14
Legend
0
1
Testing outputs
Connected Motor M41 Moteur 1 Parameter setting Remote controls en 24/01/2002 16:52:40

*"Input, output, indicator status" screen.*

## Checking of logic input connection

### Procedure

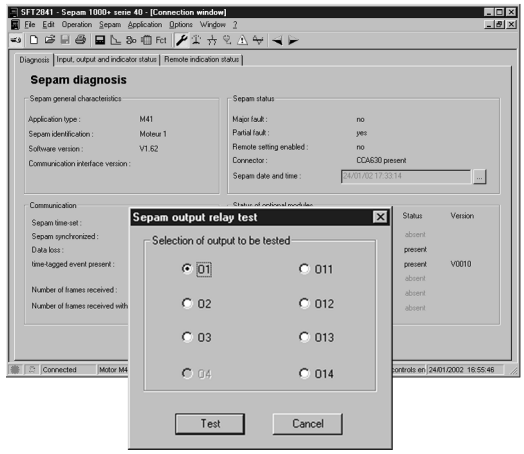
Proceed as follows for each input:

**1. If the input supply voltage is present,** use an electric cord to short-circuit the contact that delivers logic data to the input.

**2. If the input supply voltage is not present,** apply a voltage supplied by the DC voltage generator to the terminal of the contact linked to the chosen input, being sure to comply with the suitable polarity and level.

**3. Observe the change of status of the input** using the SFT2841 software, in the "Input, output, indicator status" screen.

4. At the end of the test, if necessary, press the SFT2841 Reset key to clear all messages and deactivate all outputs.




*"Sepam diagnosis and output relay test" screen.*

## Checking of logic output connection

### Procedure

Check carried out using the "Output relay test" function, activated via the SFT2841 software, in the "Sepam Diagnosis" screen.

Only output O4, when used for the watchdog, can be tested.

This function requires prior entry of the "Parameter setting" password.

1. Activate each output relay using the buttons in the SFT2841 software.
2. The activated output relay changes status over a period of 5 seconds.
3. Observe the change of status of the output relay through the operation of the related switchgear (if it is ready to operate and is powered), or connect a voltmeter to the terminals of the output contact (the voltage cancels itself out when the contact closes).
4. At the end of the test, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

# Validation of the complete protection chain Checking of optional modules connection

## Validation of the complete protection chain

### Principle

The complete protection chain is validated during the simulation of a fault that causes tripping of the breaking device by Sepam.

### Procedure

1. Select one of the protection functions that triggers tripping of the breaking device and separately, according to their incidence in the chain, the function or functions related to the programmed or reprogrammed parts of the program logic.
2. According to the selected function or functions, inject a current and/or apply a voltage that corresponds to a fault.
3. Observe the tripping of the breaking device and the operation of the adapted parts of the program logic.

**At the end of all the voltage and current application type checks, put the covers back on the test terminal boxes.**

## Checking of optional module connection

### Checking of RTD inputs to the MET148-2 module

The temperature monitoring function provided by Sepam T40, T42, T50, T52, M40, M41 and G40 units checks the connection of each RTD that is configured.
An "RTD FAULT" alarm is generated whenever one of the RTDs is detected as being short-circuted or disconnected (absent).
To identify the faulty RTD or RTDs:
1. Display the temperature values measured by Sepam using the SFT2841 software.
2. Check the consistency of the temperatures measured:
- the temperature displayed is "*****" if the RTD is short-circuited (T < -35 °C)
- the temperature displayed is "-*****" if the RTD is disconnected (T > 205 °C).

### Checking of analog output connection to the MSA141 module

1. Identify the measurement associated by parameter setting to the analog output using the SFT2841 software.
2. Simulate, if necessary, the measurement linked to the analog output by injection.
3. Check the consistency between the value measured by Sepam and the indication given by the device connected to the analog output.

# Test sheet
## Sepam series 40

**Project:** ..... **Type of Sepam** ☐☐☐

**Switchboard:** ..... **Serial number** ☐☐☐☐☐☐☐

**Cubicle:** ..... **Software version** V☐☐☐☐

## Overall checks

**Check off the box ☐ when the check has been made and been conclusive**

| Type of check | |
|---|---|
| Preliminary general examination, prior to energizing | ☐ |
| Energizing | ☐ |
| Parameter and protection settings | ☐ |
| Logic input connection | ☐ |
| Logic output connection | ☐ |
| Validation of the complete protection chain | ☐ |
| Validation of the customized logic functions (if necessary) | ☐ |
| Analog output connection to the MSA141 module (if necessary) | ☐ |
| Temperature sensor input connection to the MET148-2 module (for type T40, T42, T50, T52, M40, M41, G40)) | ☐ |

## Checking of phase current and voltage inputs

**Check off the box ☐ when the check has been made and been conclusive**

| Type of check | Test performed | Result | Display | |
|---|---|---|---|---|
| **Phase current and phase voltage input connection** | Secondary injection of CT rated current, i.e. 1 A or 5 A | CT rated primary current | I1 = ..... | ☐ |
| | | | I2 = ..... | |
| | | | I3 = ..... | |
| | Secondary injection of phase voltage (the value to be injected depends on the test being performed) | VT rated primary phase-to-neutral voltage Uns/$\sqrt{3}$ | V1 = ..... | ☐ |
| | | | V2 = ..... | |
| | | | V3 = ..... | |
| | | Phase displacement φ(V, I) ≈ 0° | φ1 = ..... | ☐ |
| | | | φ2 = ..... | |
| | | | φ3 = ..... | |

| **Tests performed on:** ..... | **Signatures** |
|---|---|
| **By:** ..... | |

**Comments:**

.....

.....

.....

# Test sheets
Sepam series 40

**Project:**..... **Type of Sepam** ☐☐☐

**Switchboard:** ..... **Serial number** ☐☐☐☐☐☐☐☐☐

**Cubicle:**..... **Software version** V☐☐☐☐☐

## Checking of residual current and residual voltage inputs

**Check off the box ☐ when the check has been made and been conclusive**

| Type of check | Test performed | Result | Display |
|---|---|---|---|
| **Residual current input connection** | Injection of 5 A into the core balance CT primary circuit | Injected current value | I0 =..... ☐ |
| | When applicable, secondary injection of the rated phase-to-neutral voltage of a phase VT Uns/$\sqrt{3}$ | VT rated primary phase-to-neutral voltage Unp/$\sqrt{3}$ | V0 = ..... |
| | | Phase displacement φ (V0, I0) ≈ 0° | φ0 =..... |
| **Residual voltage input connection** | Secondary injection of the rated voltage of the VTs in an open delta arrangement (Uns/$\sqrt{3}$ or Uns/3) | VT rated primary phase-to-neutral voltage Unp/$\sqrt{3}$ | V0 = ..... ☐ |
| | When applicable, secondary injection of CT rated current, i.e. 1 A or 5 A | CT rated primary current | I0 =..... |
| | | Phase displacement φ (V0, I0) ≈ 0° | φ0 =..... |
| **Residual current and residual voltage input connection** | Injection of 5 A into the core balance CT primary circuit | Injected current value | I0 =..... ☐ |
| | Secondary injection of the rated voltage of the VTs in an open delta arrangement (Uns/$\sqrt{3}$ or Uns/3) | VT rated primary phase-to-neutral voltage Unp/$\sqrt{3}$ | V0 = ..... |
| | | Phase displacement φ (V0, I0) ≈ 0° | φ0 =..... |

| **Tests performed on:** ..... **By:** ..... | **Signatures** |
|---|---|

**Comments:**

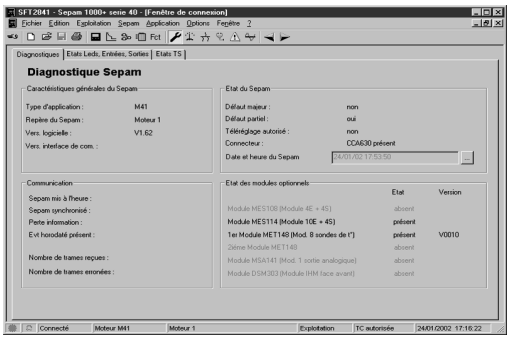
.....

.....

.....

**Sepam** has a large number of self-tests that are carried out in the base unit and additional modules. The purpose of the self-tests is:
■ to detect failures that may lead to nuisance tripping or the failure to trip when a fault occurs
■ to put Sepam in the fail-safe position to avoid user errors
■ to notify the operator that a maintenance operation is required.
The "Sepam diagnosis" screen of the SFT2841 software provides access to data on the status of the base unit and optional modules.

MT11196


SFT2841 - Sepam 1000+ serie 40 - [Fenêtre de connexion]
Diagnostique Sepam
Caractéristiques générales du Sepam
Type d'application : M41
Repère du Sepam : Moteur 1
Vers. logicielle : V1.62
Vers. interface de com. :
Etat du Sepam
Défaut majeur : non
Défaut partiel : oui
Téléréglage autorisé : non
Connecteur : CCA630 présent
Date et heure du Sepam
Communication
Sepam mis à l'heure :
Sepam synchronisé :
Perte information :
Evt horodaté présent :
Nombre de trames reçues :
Nombre de trames erronées :
Etat des modules optionnels
Etat
Version
Module MES114 (Module 10E + 4S) présent
1er Module MET148 (Mod. 8 sondes de t°) présent V0010
2ème Module MET148 absent
Module MSA141 (Mod. 1 sortie analogique) absent
Module DSM303 (Module IHM face avant) absent
Connecté
Moteur M41
Moteur 1
Exploitation
TC autorisée
24/01/2002 17:16:22

*Sepam Diagnosis" screen.*

## Shutdown of the base unit in fail-safe position

The base unit goes into the fail-safe position in the following conditions:
■ detection of an internal failure by the self-tests
■ sensor interface connector missing (CCA630, CCA634 or CCA670)
■ no connection of one of the 3 LPCT sensors to the CCA670 (connectors L1, L2 and L3)
■ MES module configured but missing.
See “List of self-tests which place Sepam in the fail-safe position” page 136.

The fail-safe position is conveyed by:
■ ON indicator on
■ indicator on the base unit steadily on
■ relay O4 "watchdog" in fault position
■ output relays dropped out
■ all protection units inhibited
■ display showing fault message

■ indicator on DSM303 module (remote advanced UMI option) flashing.

## Downgraded operation

The base unit is in working order (all the protection functions activated are operational) and indicates that one of the optional modules such as DSM303, MET148-2 or MSA141 is faulty or else that a module is configured but not connected.
See “List of self-tests which do not place Sepam in the fail-safe position” page 136.

According to the model, this operating mode is conveyed by:
■ Sepam with integrated advanced UMI (MD base):
□ ON indicator on
□ indicator on the base unit flashing, including when the display is out of order (off)
□ indicator on the MET or MSA module faulty, steadily on.
The display shows a partial fault message and indicates the type of fault by a code:
□ code 1: inter-module link fault
□ code 3: MET module unavailable
□ code 4: MSA module unavailable.
■ Sepam with remote advanced UMI, MX base + DSM303:
□ ON indicator on
□ indicator on the base unit flashing
□ indicator on the MET or MSA module faulty, steadily on
□ the display indicates the type of fault by a code (same as above).
Special case of faulty DSM303:
□ ON indicator on
□ indicator on base unit flashing
□ indicator on DSM steadily on
□ display off.
This Sepam operating mode is also transmitted via the communication link.

## RTD fault

Each temperature monitoring function, when activated, detects whether the RTD associated with the MET148-2 module is short-circuited or disconnected.
When this is the case, the alarm message "RTD FAULT" is generated.
Since this alarm is common to the 8 functions, the identification of the faulty RTD or RTDs is obtained by looking up the measured values:
■ measurement displayed "****" if the sensor is short-circuited (T < -35 °C or -31 °F)
■ measurement displayed "-****" if the sensor is disconnected (or T > +205 °C or +401 °F)

## Other faults

Specific faults indicated by a screen:
■ DSM303 version incompatible (if version < V0146).

# Maintenance

**CAUTION**

**HAZARD OF DAMAGE TO SEPAM**

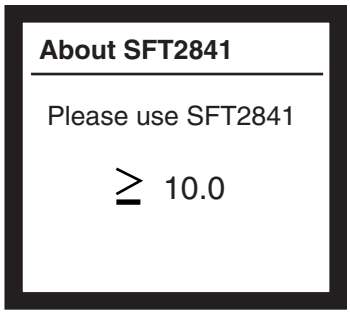
- Do not open the Sepam base unit.
- Do not attempt to repair any components in the Sepam range, either in the base unit or an accessory.

**Failure to follow these instructions can result in equipment damage.**

## Replacement and repair

When Sepam or a module is considered to be faulty, have it replaced by a new product or module, since the components cannot be repaired.

DE80236




*SFT2841 compatible version screen.*

## Compatibility of Sepam version/SFT2841 version

The About SFT2841 screen indicates the minimum version of SFT2841 that is compatible with the Sepam being used.
To display this screen on the Sepam UMI, press the key several times to bring up the SFT2841 compatible version screen.
Check that the SFT2841 software version used is higher than or the same as that indicated on the Sepam screen.
If the SFT2841 software version is lower than the minimum version compatible with the Sepam being used, the SFT2841 software cannot be connected to Sepam and the SFT2841 software displays the following error message: SFT2841 software version incompatible with the connected device.

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**

- Only qualified personnel should maintain this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Obey all existing safety instructions when commissioning and maintaining high-voltage equipment.
- Beware of potential hazards and wear personal protective equipment.

**Failure to follow these instructions will result in death or serious injury.**

## Preventive maintenance

### General

The logic inputs and outputs and the analog inputs are the parts of Sepam least covered by the self-tests. (See “List of self-tests which place Sepam in the fail-safe position” page 136).
They should be tested during a maintenance operation.
The recommended interval between preventive maintenance operations is 5 years.

### Maintenance tests

To perform maintenance on Sepam, see section “Sepam commissioning tests” page 286. Carry out all the recommended commissioning tests according to the type of Sepam to be tested.
First test all the logic inputs and outputs involved in tripping the circuit breaker.
A test of the complete chain including the circuit breaker is also recommended.

## Firmware evolutions

The table below describes the firmware version history of the Sepam base.
The following information is provided for each firmware version:
- release date,
- compatible base version(s),
- serial number range of compatible Sepam bases,
- new features added to the Sepam base.

The base version represents the hardware version of the Sepam base.

| Firmware version | Firmware version release date | Compatible base version | Base serial number | New features |
|---|---|---|---|---|
| V1.00 | July 2001 | Base 1 | 0132001 to 0209062 | First version |
| V2.00 | March 2002 | Base 1 | 0209063 to 0527999 | ■ New applications added: G40, M41, S42, T40 and T42<br>■ Logic equation editor and customized messages available<br>■ CTs and energy monitoring available<br>■ Compliance with the new MSA141 analog output module and the new MET148-2 temperature sensor module |
| V3.00 | July 2005 | Base 1 | 0528001 to 0622999 | ■ Compliance with the new ACE969 multi-protocol interfaces<br>■ Remote connection of Sepam setting software SFT2841 V8.0 and higher |
| V4.00 | June 2006 | Bases 1, 2, 3 and 4 | 0623001 to 0722999 | ■ Metering 3 phase currents with only 2 CTs<br>■ Communication protocol DNP3: new possibility to set the threshold of the measurement dead band that starts the transmission event.<br>■ Sepam time and date setting using the setting software SFT2841 |
| V5.00 | June 2007 | Bases 1, 2, 3 and 4 | 0723001 to 08129999 | ■ 49 RMS function (Thermal overload) improvement:<br>□ Improvement of the functioning time accuracy when tripping has to occur in a few seconds<br>□ Use of 48/51LR (excessive starting time and locked rotor) protection threshold instead of the actual fixed threshold to detect the motor starting<br>□ Improvement of the choice of setting groups to take into account the appropriate time constants as soon as the motor starts<br>■ Pre-assigned remote indication bit TS130 for the tripping information is now available in communication |
| V5.03 | August 2008 | Bases 1, 2, 3 and 4 | 08130001 to 09139999 | New application S43 added |
| V6.00 | March 2009 | Bases 1, 2, 3 and 4 | 09140001 to 09349999 | ■ Supervision communication is checked by using remote control orders (TC) broadcasting. If the TC is not received in the correct setting time interval, the Sepam trips.<br>■ Inductive and capacitive remote indication (TS) event generation disabled to prevent logbook saturation on underload networks |
| V6.01 | September 2009 | Bases 1, 2, 3 and 4 | 09350001 to 09499999 | Hardware evolution of the Sepam series 40 base 3. |
| V6.02 | August 2010 | Bases 1, 2, 3 and 4 | | New harmonic 2 restraint function on the earth fault protection (ANSI 50N/51N) |
| V6.05 | October 2010 | Bases 1, 2, 3 and 4 | | Same event list management for all Sepam (series 20, series 40 and series 80). |
| V7.00 | December 2009 | Bases 3 and 4 | 09500001 to 10469999 | ■ New applications added:<br>S50, S51, S52, S53, T50 and T52 applications created based on the S40, S41, S42, S43, T40 and T42 applications enhanced with the following functions:<br>□ Fault locator function (ANSI 21FL)<br>□ Broken conductor protection (ANSI 46BC)<br>□ Cold load pick-up on I and Io functions.<br>■ New functions added on all applications:<br>□ Cable arcing fault detection (based on an harmonic 2 restraint function on ANSI 50/51)<br>□ New harmonic 2 restraint function on the earth fault protection (ANSI 50N/51N)<br>□ Supervision communication is checked by using remote control orders (TC) broadcasting. If the TC is not received in the correct setting time interval, the Sepam trips.<br>□ Inductive and capacitive remote indication event generation disabled to prevent logbook saturation on underload networks<br>□ Under voltage functions (ANSI 27/27S) setting point<br>□ Positive sequence under voltage function (ANSI 27D) setting point |
| V7.04 | November 2010 | Base 3 and 4 | 10470001 | Same event list management for all Sepam (series 20, series 40 and series 80). |
| V8.00 | March 2010 | Base 3 and 4 | | ■ New applications M40, S44 and S54 |

# Firmware modifications

## General upward compatibility

The following table presents the compatibility of a firmware version with the different hardware base versions.

| Firmware version | Hardware evolutions | | | |
|---|---|---|---|---|
| | Base 1 | Base 2 June 2006 | Base 3 August 2009 | Base 4 July 2010 |
| **1.XX** | □ | - | - | - |
| **2.XX** | □ | - | - | - |
| **3.XX** | □ | - | - | - |
| **4.XX** | □ | □ | □ | □ |
| **5.XX** | □ | □ | □ | □ |
| **6.00** | □ | □ | □ | □ |
| **6.01** | □ | □ | □ | □ |
| **6.02** | □ | □ | □ | □ |
| **6.05** | ■ | ■ | □ | □ |
| **7.XX** | - | - | □ | □ |
| **8.XX** | - | - | ■ | ■ |

■ *compatible with all features*
□ *compatible but with limited features*
- *not compatible*

**Nota :** Sepam firmware versions V7.00 and above are compatible only with Sepam bases 3 and above, manufactured after August 2009, with a serial number above 09350001.

**Nota :** The disturbance-recording backup function is available only with Sepam bases 4 and above, with a serial number above 10300001.

# Notes

# Notes

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